Nokia Customer Care
NHL-12 Series Transceivers

7 - RF Description & Troubleshooting

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1. RF Description and Troubleshooting

The RF module performs the necessary high frequency operations of the GSM850/1800/1900 tripleband (EDGE) engine. Both the transmitter and receiver have been implemented by using direct conversion architecture which means that the modulator and demodulator operate at the channel frequency.

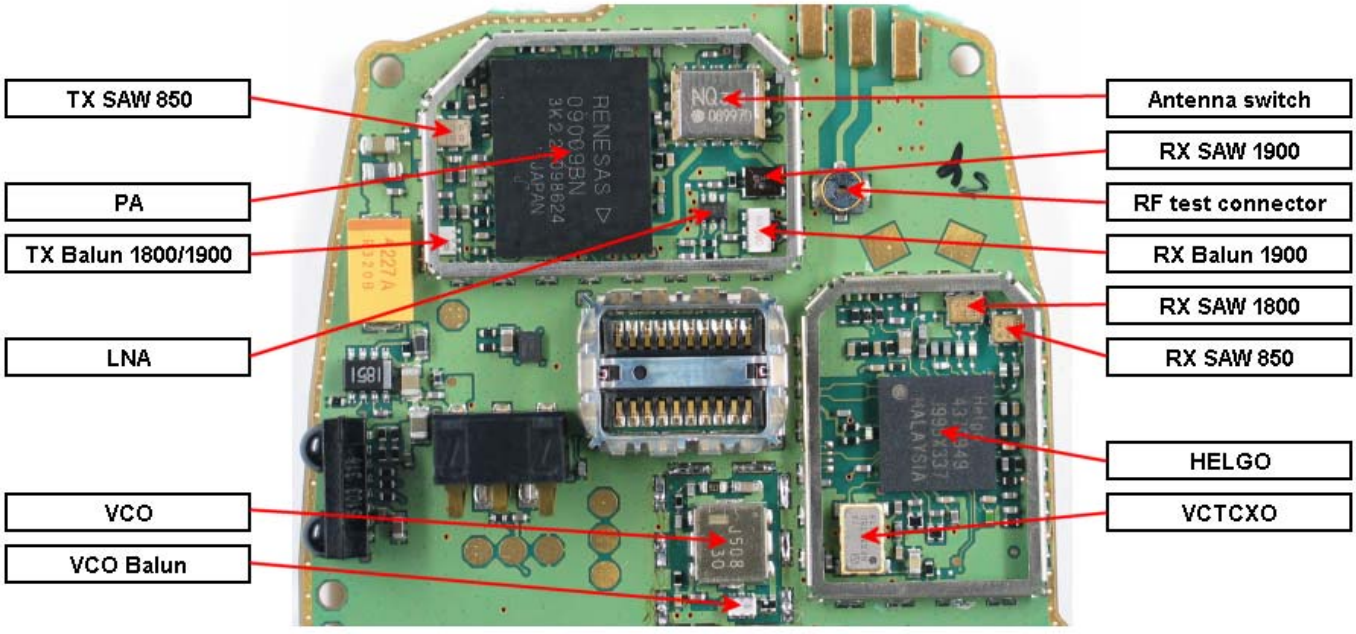
The core of the RF is an application-specific integrated circuit, Helgo. Another core component is a power amplifier module which includes two amplifier chains, one for GSM850 and the other for GSM1800/1900.

Other key components include:

- 26 MHz VCTCXO for frequency reference
- 3290-3980 MHz SHF VCO (super high frequency voltage controlled oscillator)
- Antenna switch module
- Four SAW filters
- Three transformer baluns

RF key component placement

Figure 1:RF key components



The control information for the RF is coming from the baseband section of the engine through a serial bus, referred later on as RFBus. This serial bus is used to pass the information about the frequency band, mode of operation, and synthesizer channel for the RF. In addition, exact timing information and receiver gain settings are transferred through the RFBus. Physically, the bus is located between the baseband ASIC called UPP and Helgo.

Using the information obtained from the UPP, Helgo controls itself to the required mode of operation and further sends control signals to the front end and power amplifier modules. In addition to the RFBus, there are still other interface signals for the power control loop and VCTCXO control and for the modulated waveforms.

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RF circuitry is located on one side of the 8-layer PWB.

The possible EMC leakage is prevented by using metal cans. The RF circuits are separated into three blocks:

- PA, antenna switch module, Rx 1900 LNA, Rx 1900 SAW filter, Rx 1900 transformer balun, Tx 1800/1900 transformer balun and Tx 850 SAW filter
- Helgo RF IC, VCTCXO, Rx 850 SAW filter and Rx 1800 SAW filter
- VCO and transformer balun for VCO

The RF transmission lines constitute of striplines and microstriplines after PA.

The baseband circuitry is located on one side of the board, which is shielded with a metallized frame and ground plane of the UI board.

RF measurement points

Figure 2: RF measurement points - Bottom

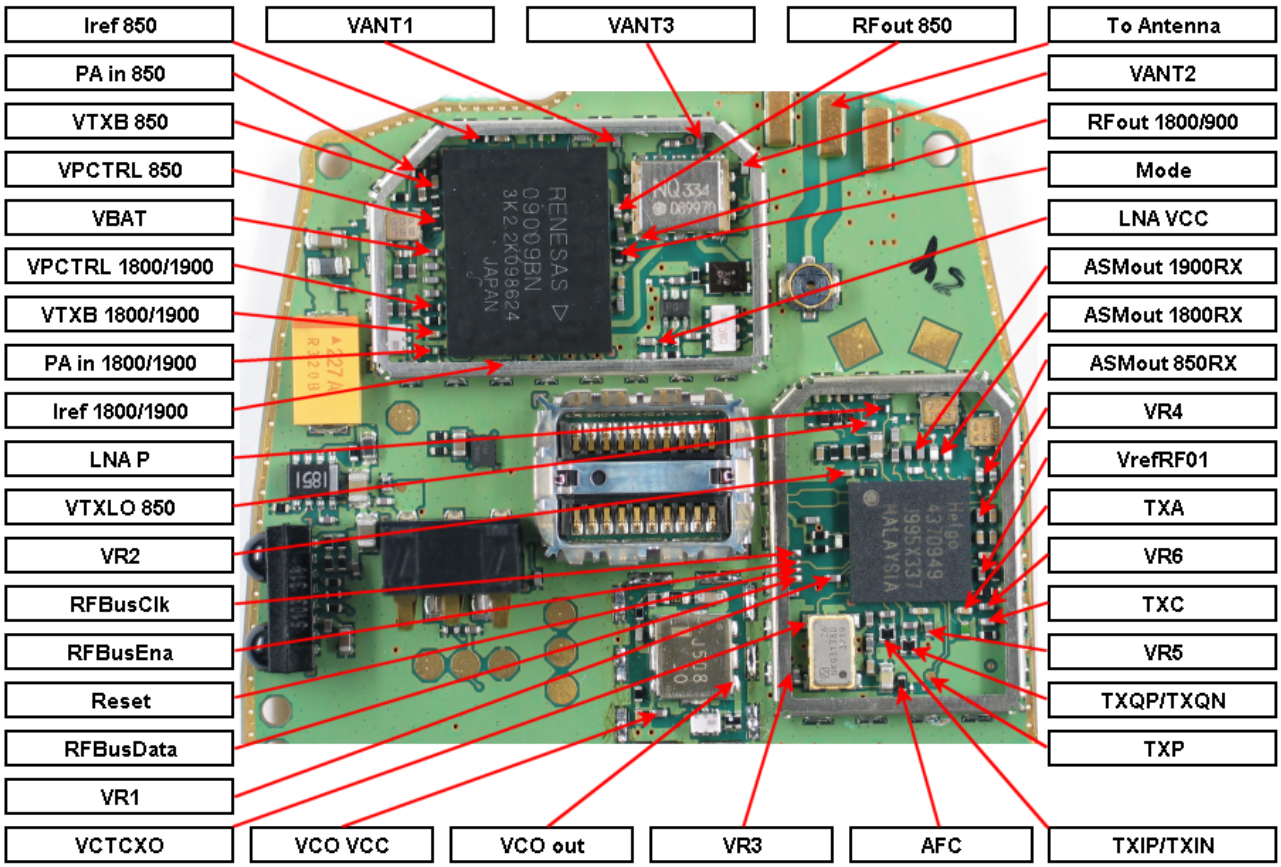

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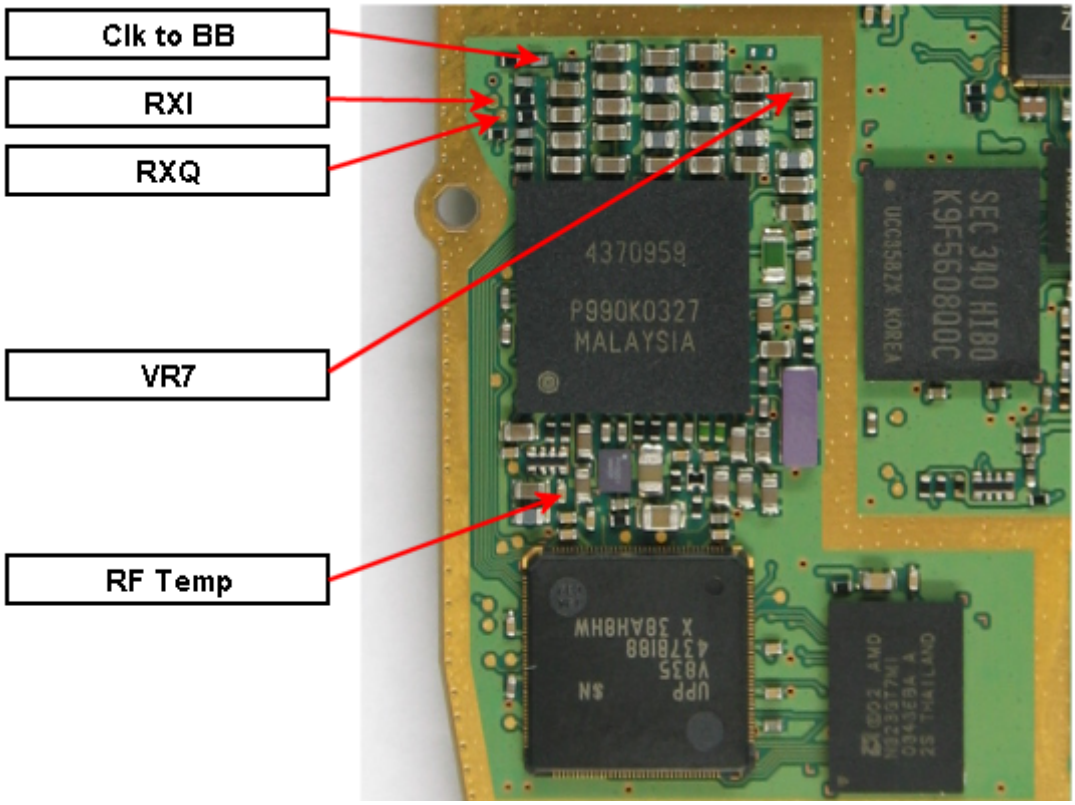
Figure 3: RF measurement points - Top



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Test points

Table 1: Test points

Signal name	Reference	Signal name	Reference
VBAT	C7020	To Antenna	J7100
VR1	C7306	VANT 1	C7102
VR2	C7326	VANT 2	C7101
VR3	C7201	VANT 3	C7100
VR4	C7303	RFBusEna1X	R7302
VR5	C7304	RFBusData	R7302
VR6	C7302	RFBusClk	R7302
VR7	C2230	RESET	R7302
VrefRF01	C7311	VCTCXO	G7200
RFTemp	C2226	Clk to BB	C2902
VCO out	G7201	RFout 1800/1900	Z7100
VCO VCC	C7205	TXA	C7313
AFC	R7200	TXC	C7314
RXI	J7301	TXP	J7303
RXQ	J7300	Mode	R7002
ASM out 850RX	L7100/L7101	VPECTRL3 (ALC)	C7329
ASM out 1800RX	L7102/L7103	Iref 850 (IPA1)	R7001
ASM out 1900RX	C7112/C7113	Iref 1800/1900 (IPA2)	R7000
LNA VCC	C7109	VTXB 850	C7013
LNA P	R7202	VTXB 1800/1900	C7014
TXIP / TXIN	R7305	VPCTRL 850	R7003
TXQP / TXQN	R7306	VPCTRL 1800/1900	R7007
PA in 850	R7005	PA in 1800/1900	L7003
RFout 850	L7004	VTXLO 850	C7320

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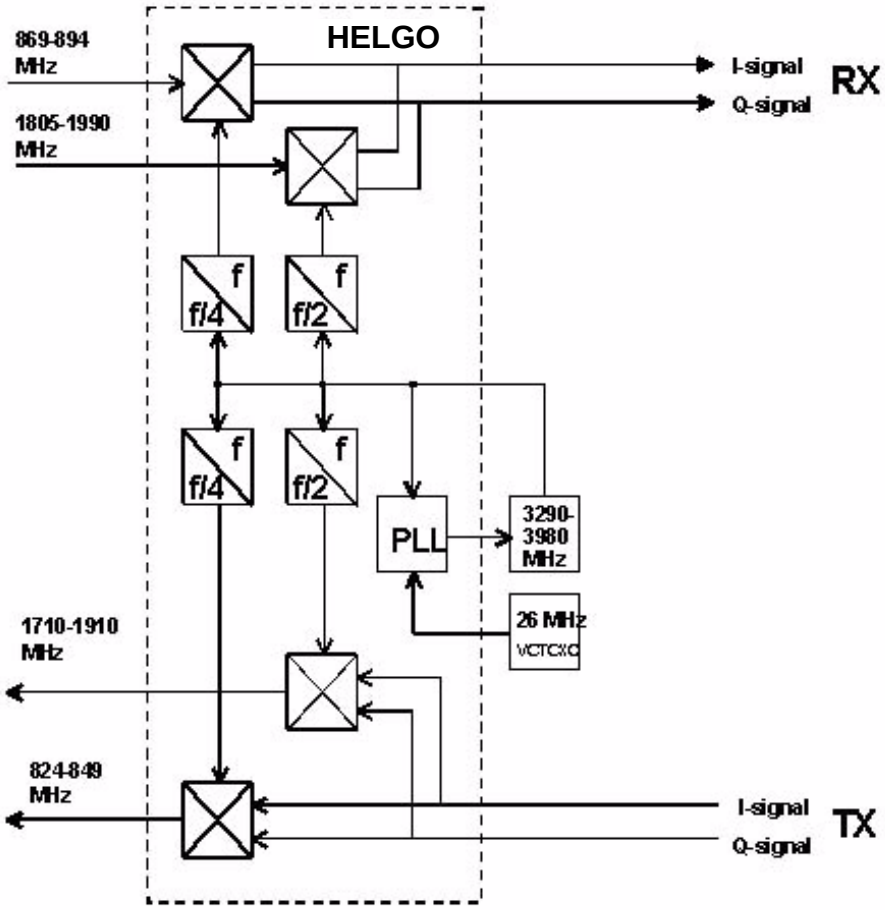
2. RF Implementation in NHL-12

RF frequency plan

RF frequency plan is shown below. The VCO operates at the channel frequency multiplied by two or four depending on the frequency band of operation. This means that the baseband modulated signals are directly converted up to the transmission frequency and the received RF signals directly down to the baseband frequency.

Figure 4:RF Frequency plan



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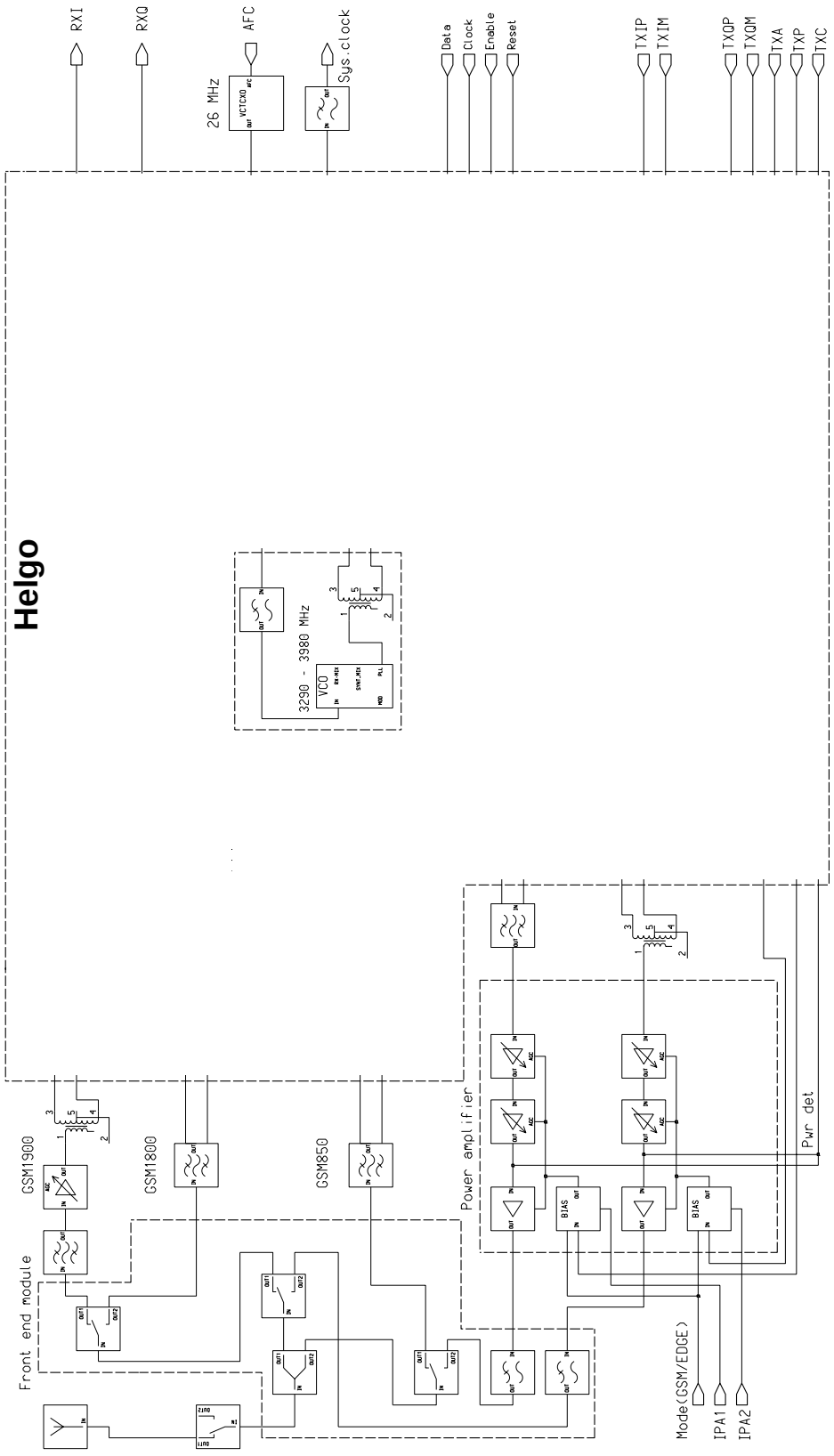
RF block diagram NHL-12

Figure 5:RF Block diagram



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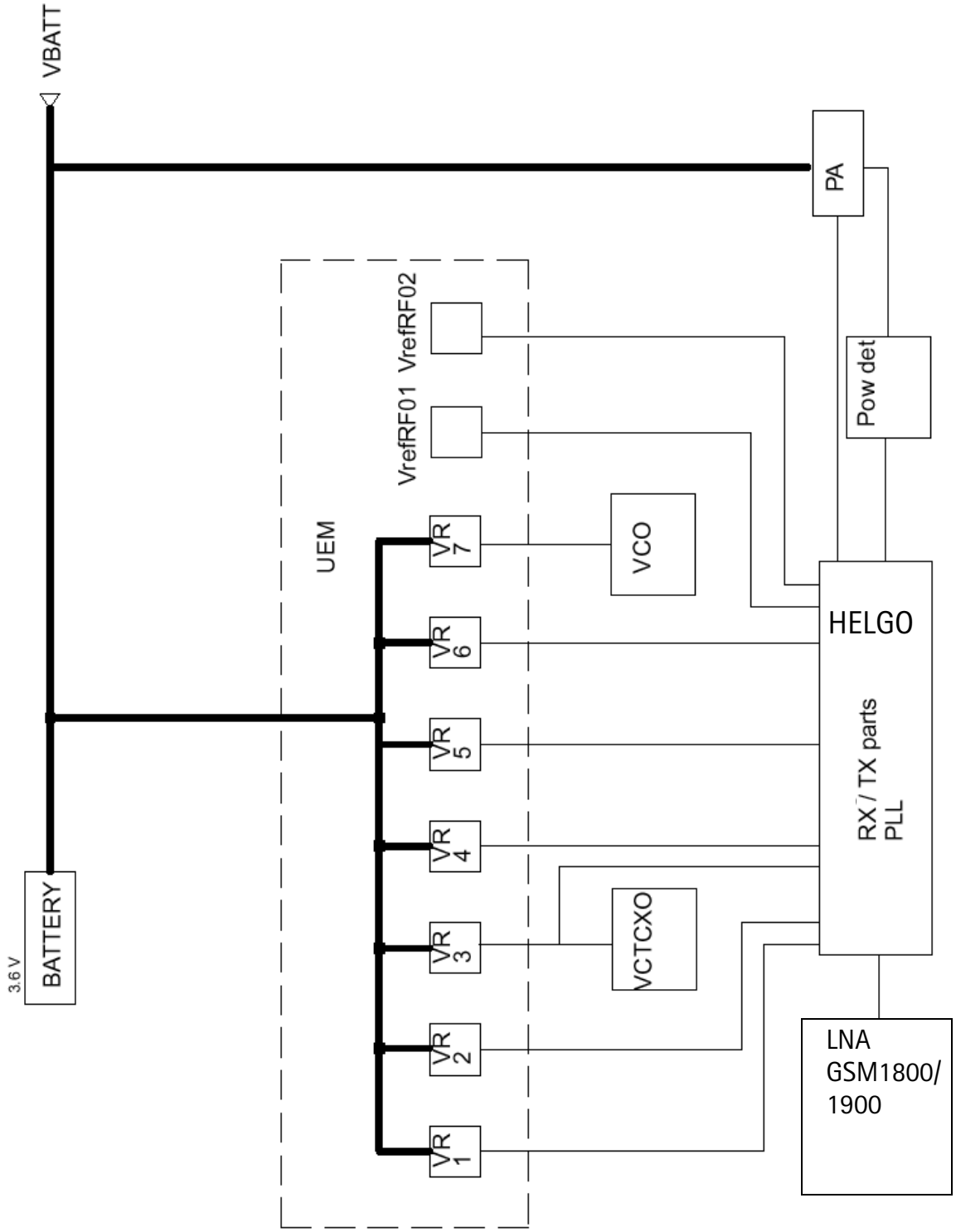
RF power supply configuration

Figure 6:Power distribution diagram



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3. Introduction to RF troubleshooting

All measurements must be done using a spectrum analyzer with a high-frequency high-impedance passive probe (LO-/reference frequencies and RF power levels) and an oscilloscope with a 10:1 probe (DC-voltages and low frequency signals).

The RF section is build around one RF ASIC (HELGO N7300). Before changing HELGO, please check the following things: supply voltages and serial communication coming from baseband to HELGO are both OK.

Apart from key components described in this document here are a lot of discrete components (resistors, inductors and capacitors) which troubleshooting is done by checking if soldering of the component is done properly (for factory repairs checking if it is missing from the PWB). Capacitor can be checked for shortening and resistors for value by means of an ohmmeter, but be aware that in-circuit measurements should be evaluated carefully.

Please be aware that all measured voltages or RF levels in this document are rough figures. Especially RF levels vary due to different measuring equipment or different grounding of the used probe. When using the RF probe, use metallic tweezers to connect the probe ground to the PWB ground as close to the measurement point as possible.

Please note that the grounding of the PA module is directly below PA module, therefore it is difficult to check or change. **Most RF semiconductors are static discharge sensitive!** ESD protection must be taken care of during repair (ground straps and ESD soldering irons). HELGO and PA are moisture sensitive which means that parts must be pre-baked prior to soldering.

For easier troubleshooting, this RF troubleshooting document is divided into sections.

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4. Receiver Description and Troubleshooting

Receiver

Each receiver path is a direct conversion linear receiver. From the antenna, the received RF signal is fed to a front end module where a diplexer first divides the signal into three separate paths according to the band of operation: either lower GSM850 or upper GSM1800 or GSM1900 path.

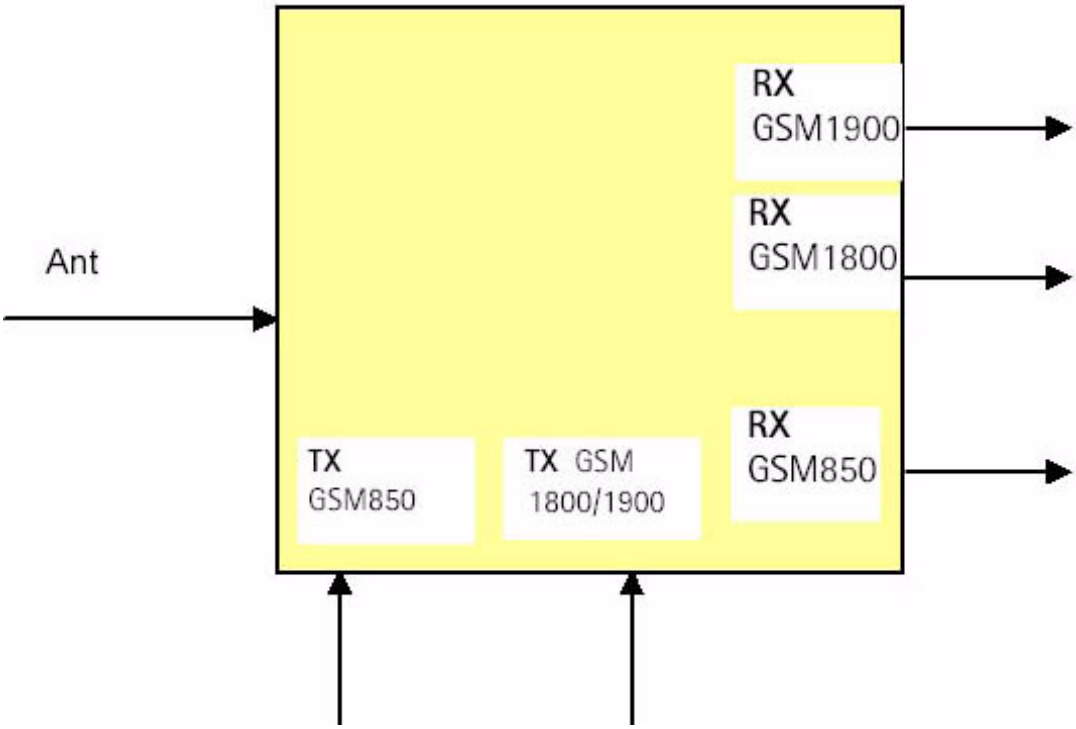
Most of the receiver circuitry is included in Helgo.

Rx front-end

The front-end features include:

- Antenna 50 ohm input
- Rx GSM850, GSM1800 and GSM 1900 50 ohms inputs
- Txs single 50 ohm input
- 3 control lines from the Helgo

Figure 7: Front-end



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Receiver characteristics

Item	Values, GSM850/1800/1900
Type	Direct conversion, Linear, FDMA/TDMA
LO frequencies	3476...3576 MHz / 3610...3760 MHz/ 3860...3980 MHz
Typical 3 dB bandwidth	+/- 91 kHz
Sensitivity	min. - 102 dBm (normal condition)
Total typical receiver voltage gain (from antenna to Rx ADC)	86 dB
Receiver output level (RF level -95 dBm)	230 mVpp, single-ended I/Q signals to Rx ADCs
Typical AGC dynamic range	83 dB
Accurate AGC control range	60 dB
Typical AGC step in LNA	30 dB GSM1800/1900 25 dB GSM850
Usable input dynamic range	-102... -10 dBm
RSSI dynamic range	-110... -48 dBm
Compensated gain variation in receiving band	+/- 1.0 dB

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General instructions for Rx troubleshooting

1. Connect the test jig (MJ-13) to a computer with a DAU-9S cable or to a FPS-8 flash prommer with an XCS-4 modular cable.

   Make sure that you have PKD-1 dongle connected to the computer's parallel port.

2. Connect a DC power supply to the module test jig with a PCS-1 cable.

3. Set the jumper connector on test jig to "regulator" position and set the DC supply voltage to 6V (test jig has internal voltage regulator of output voltage 4V).

4. Connect an RF cable to the module test jig's (MJ-13) RF connector and to RF signal generator.

5. Set the phone module to test jig and start Phoenix service software.

6. Initialize connection to the phone. (Use FBUS driver when using DAU9S and COMBOX driver when using FPS-8).

7. Choose product from the menu: File -> Choose Product -> NHL-12.

8. From the toolbar, set operating mode to "Local".

9. Activate the RF Controls window from the menu: Testing -> RF Controls.

In the RF Controls window:

- Select band "GSM850", "GSM 1800" or "GSM1900" (Default = "GSM850").
- Set Active unit to "Rx" (Default = "Rx").
- Set Operation mode to "Burst" (Default = "Burst").

For continuous mode:

- Set Operation mode to "Continuous".
- Set AGC to "12: FEG_ON + DTOS_ON + BB_30=Vgain60" (maximum gain setting used in normal mode).
- (Default = "14: FEG_ON + DTOS_ON + BB_42=Vgain72").
- Set Rx/Tx channel to 190 on GSM850 band, 700 on GSM1800 band or 661 on GSM1900 (Defaults).
- Apply

881.6671 MHz (channel 190 + 67.710 kHz offset)
1842.86771 MHz (channel 700 + 67.710 kHz offset)
1960.06771 MHz (channel 661 + 67.71 kHz)

–90 dBm signal to the RF connector (remember to compensate for cable attenuation).

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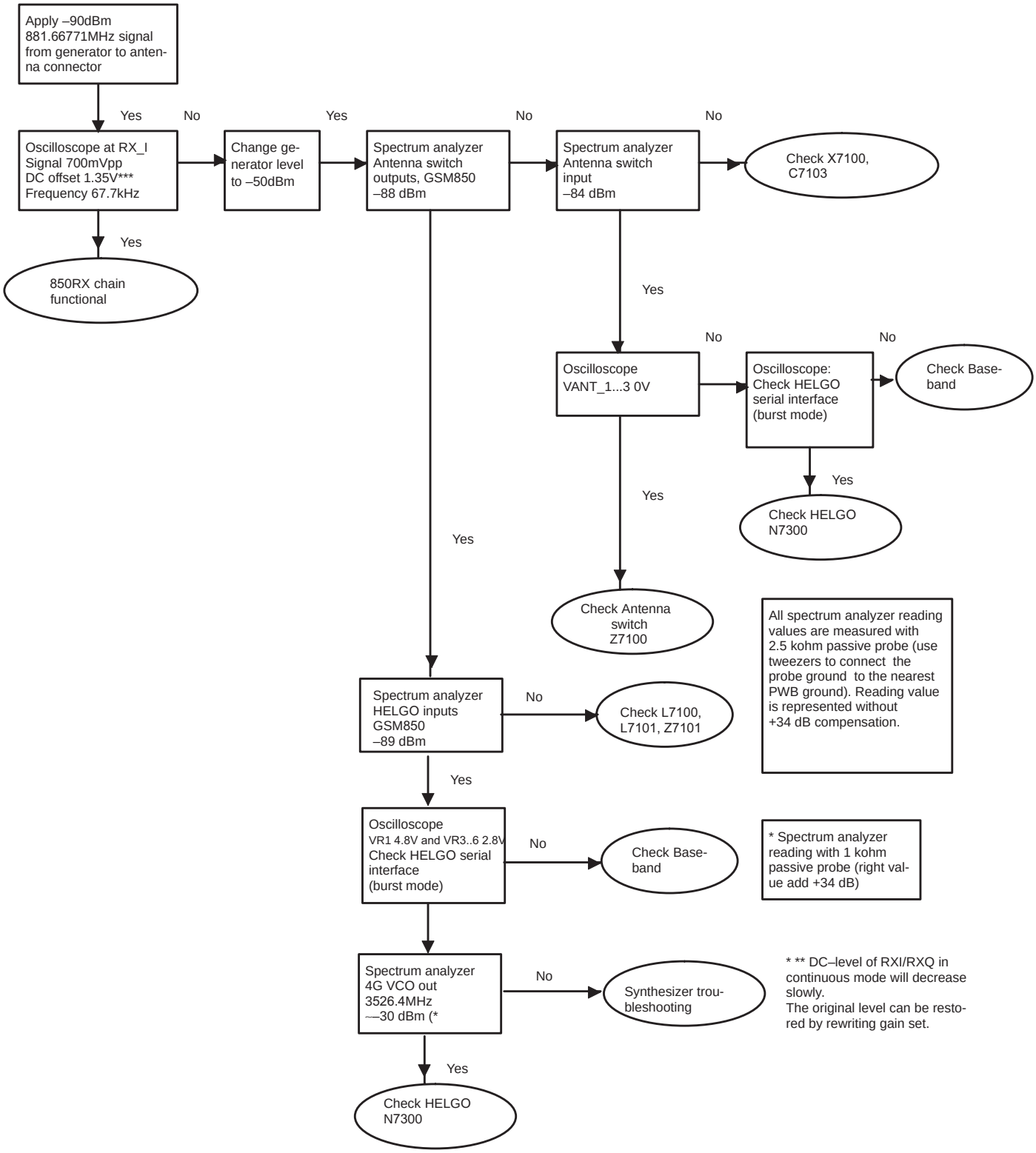
Troubleshooting charts for receiver

Troubleshooting diagram for GSM850 receiver

Phone in “Continuous” mode, AGC setting “12”.


Apply –90dBm 881.66771MHz signal from generator to antenna connector
Yes
No
Oscilloscope at RX_I Signal 700mVpp DC offset 1.35V*** Frequency 67.7kHz
Change generator level to –50dBm
Yes
No
Spectrum analyzer Antenna switch outputs, GSM850 –88 dBm
Yes
No
Spectrum analyzer Antenna switch input –84 dBm
Check X7100, C7103
Yes
850RX chain functional
Yes
No
Oscilloscope VANT_1...3 0V
No
Oscilloscope: Check HELGO serial interface (burst mode)
Check Baseband
Yes
Check HELGO N7300
Yes
Check Antenna switch Z7100
Yes
Spectrum analyzer HELGO inputs GSM850 –89 dBm
No
Check L7100, L7101, Z7101
Yes
Oscilloscope VR1 4.8V and VR3..6 2.8V Check HELGO serial interface (burst mode)
No
Check Baseband
Spectrum analyzer 4G VCO out 3526.4MHz —30 dBm (*
No
Synthesizer troubleshooting
Yes
Check HELGO N7300
All spectrum analyzer reading values are measured with 2.5 kohm passive probe (use tweezers to connect the probe ground to the nearest PWB ground). Reading value is represented without +34 dB compensation.
* Spectrum analyzer reading with 1 kohm passive probe (right value add +34 dB)
* ** DC–level of RXI/RXQ in continuous mode will decrease slowly.
The original level can be restored by rewriting gain set.

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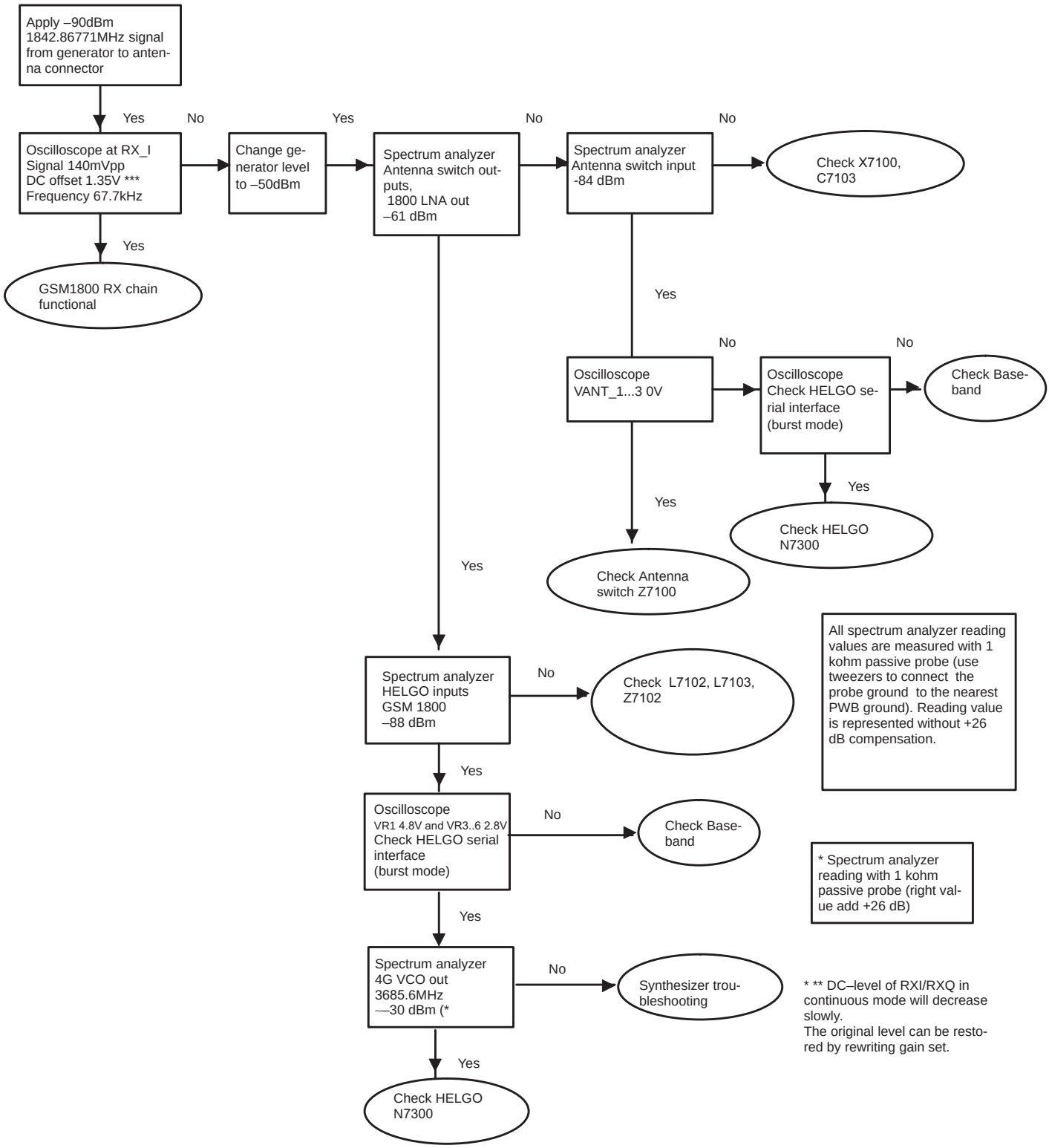
Troubleshooting diagram for GSM1800 receiver

Phone in “Continuous” mode, AGC setting “12”.


Apply –90dBm 1842.86771MHz signal from generator to antenna connector
Yes
No
Oscilloscope at RX_I Signal 140mVpp DC offset 1.35V *** Frequency 67.7kHz
Change generator level to –50dBm
Yes
No
Spectrum analyzer Antenna switch outputs, 1800 LNA out –61 dBm
Yes
No
Spectrum analyzer Antenna switch input -84 dBm
Check X7100, C7103
Yes
GSM1800 RX chain functional
Yes
No
Oscilloscope VANT_1...3 0V
No
Oscilloscope Check HELGO serial interface (burst mode)
Check Baseband
Yes
Check HELGO N7300
Yes
Check Antenna switch Z7100
Yes
Spectrum analyzer HELGO inputs GSM 1800 –88 dBm
No
Check L7102, L7103, Z7102
Yes
Oscilloscope VR1 4.8V and VR3..6 2.8V Check HELGO serial interface (burst mode)
No
Check Baseband
Yes
Spectrum analyzer 4G VCO out 3685.6MHz ~–30 dBm (*
No
Synthesizer troubleshooting
Yes
Check HELGO N7300
All spectrum analyzer reading values are measured with 1 kohm passive probe (use tweezers to connect the probe ground to the nearest PWB ground). Reading value is represented without +26 dB compensation.
* Spectrum analyzer reading with 1 kohm passive probe (right value add +26 dB)
* ** DC–level of RXI/RXQ in continuous mode will decrease slowly.
The original level can be restored by rewriting gain set.

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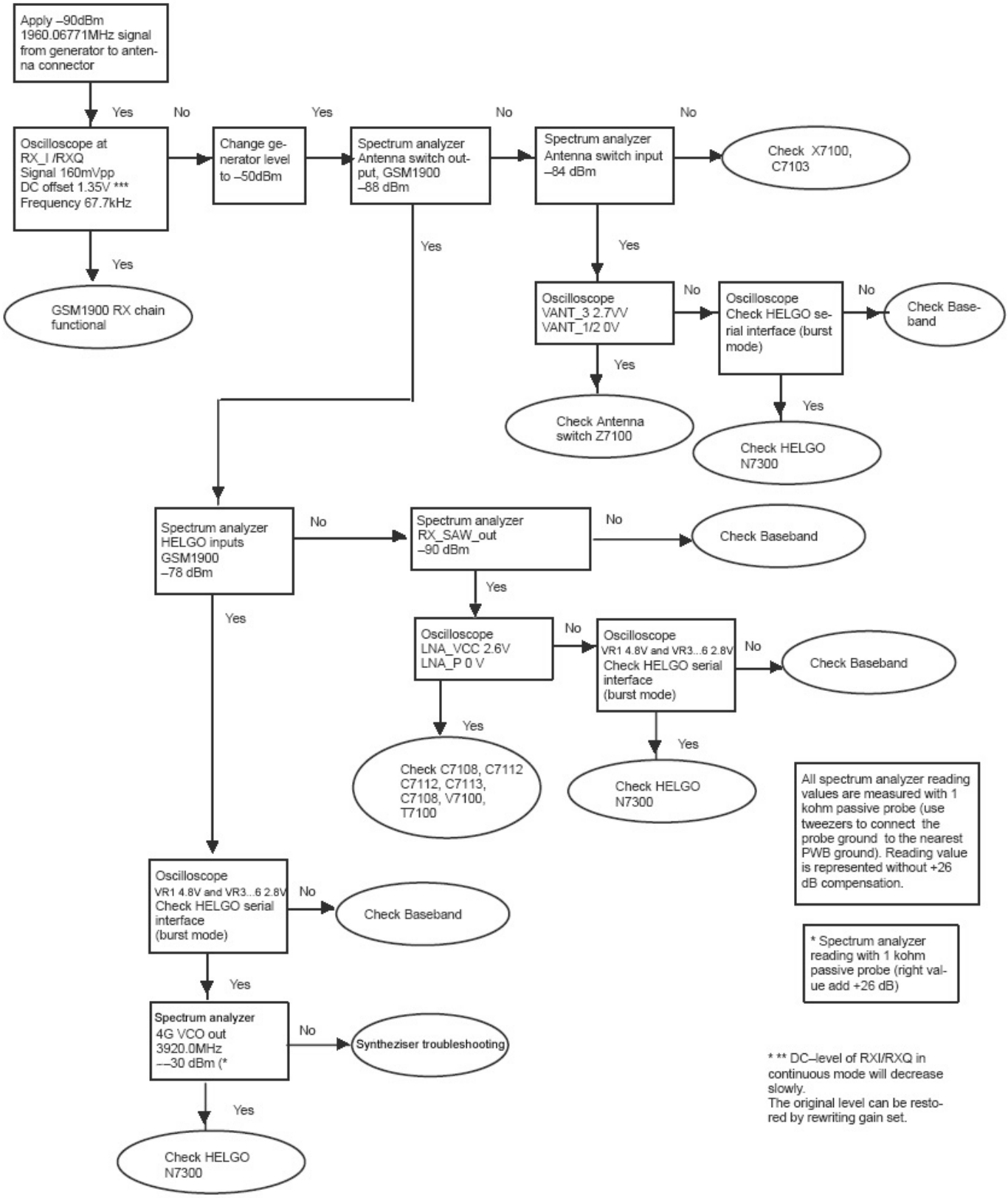
Troubleshooting diagram for GSM1900 receiver

Phone in “Continuous” mode, AGC setting “12”.


Apply –90dBm 1960.06771MHz signal from generator to antenna connector
Yes
No
Oscilloscope at RX_I /RXQ Signal 160mVpp DC offset 1.35V *** Frequency 67.7kHz
Change generator level to –50dBm
Yes
Spectrum analyzer Antenna switch output, GSM1900 –88 dBm
No
Spectrum analyzer Antenna switch input –84 dBm
No
Check X7100, C7103
Yes
GSM1900 RX chain functional
Yes
Oscilloscope VANT_3 2.7VV VANT_1/2 0V
No
Oscilloscope Check HELGO serial interface (burst mode)
No
Check Baseband
Yes
Check Antenna switch Z7100
Yes
Check HELGO N7300
Spectrum analyzer HELGO inputs GSM1900 –78 dBm
No
Spectrum analyzer RX_SAW_out –90 dBm
No
Check Baseband
Yes
Yes
Oscilloscope LNA_VCC 2.6V LNA_P 0 V
No
Oscilloscope VR1 4.8V and VR3...6 2.8V Check HELGO serial interface (burst mode)
No
Check Baseband
Yes
Check C7108, C7112 C7112, C7113, C7108, V7100, T7100
Yes
Check HELGO N7300
All spectrum analyzer reading values are measured with 1 kohm passive probe (use tweezers to connect the probe ground to the nearest PWB ground). Reading value is represented without +26 dB compensation.
* Spectrum analyzer reading with 1 kohm passive probe (right value add +26 dB)
Oscilloscope VR1 4.8V and VR3...6 2.8V Check HELGO serial interface (burst mode)
No
Check Baseband
Yes
Spectrum analyzer 4G VCO out 3920.0MHz –-30 dBm (*
No
Syntheziser troubleshooting
Yes
Check HELGO N7300
* ** DC–level of RXI/RXQ in continuous mode will decrease slowly.
The original level can be restored by rewriting gain set.

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When measuring with an oscilloscope on "RXI" or "RXQ", the following screens should be seen on a working GSM850, GSM1800 or GSM1900 receiver:

Figure 8:Rx I/Q signal, burst mode, input level –90dBm.

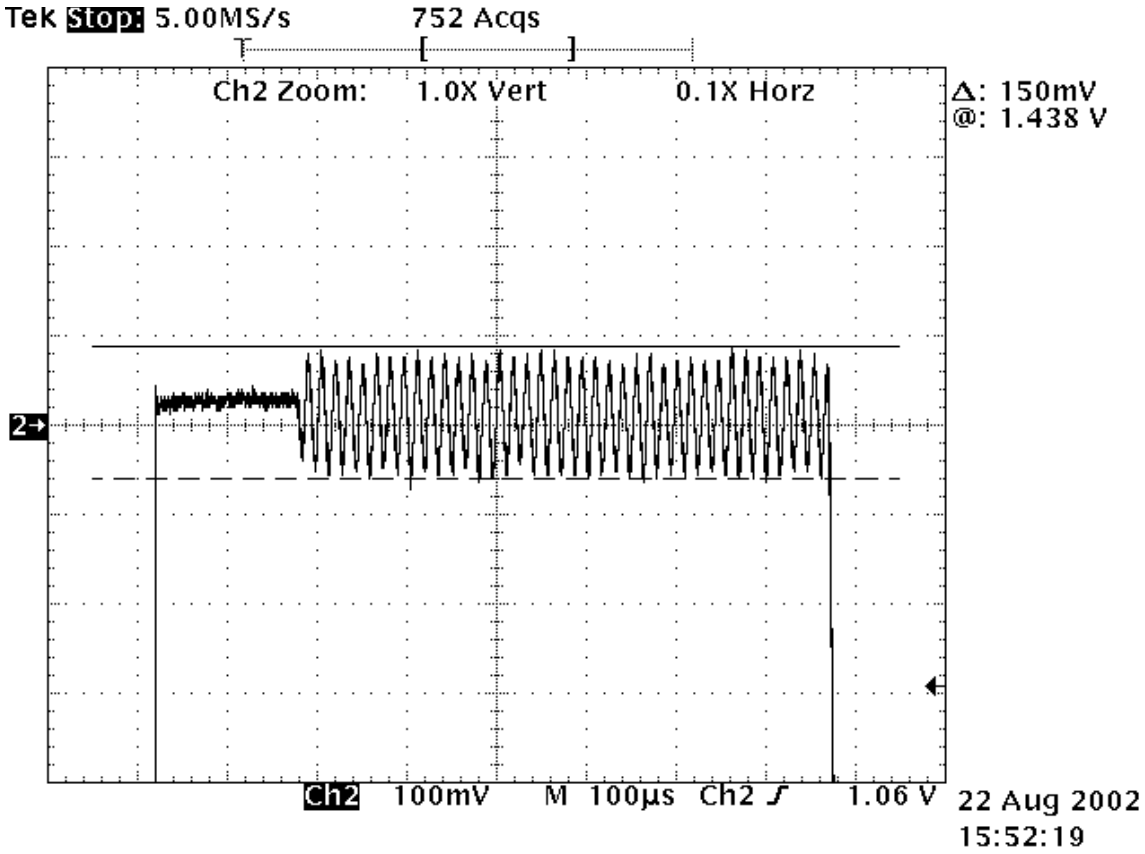

Figure 8, "Rx I/Q signal, burst mode, input level –90dBm." :

Receiver I or Q burst mode signal (channel 190) measured from test point RXI or RXQ with 881.6671 MHz signal, input level –90dBm at RF-connector.

Correct signal amplitudes approximately:

GSM850~170mVpp

GSM1800~140mVpp

GSM1900~160mVpp

Signal part frequency 67.7kHz sine.

DC level of signal part is 1.35V. DC level can variate about +/-100mV between I and Q signals and between different bands as well.

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Figure 9:GSM1900 Rx I or Q signal (trace2), burst mode.

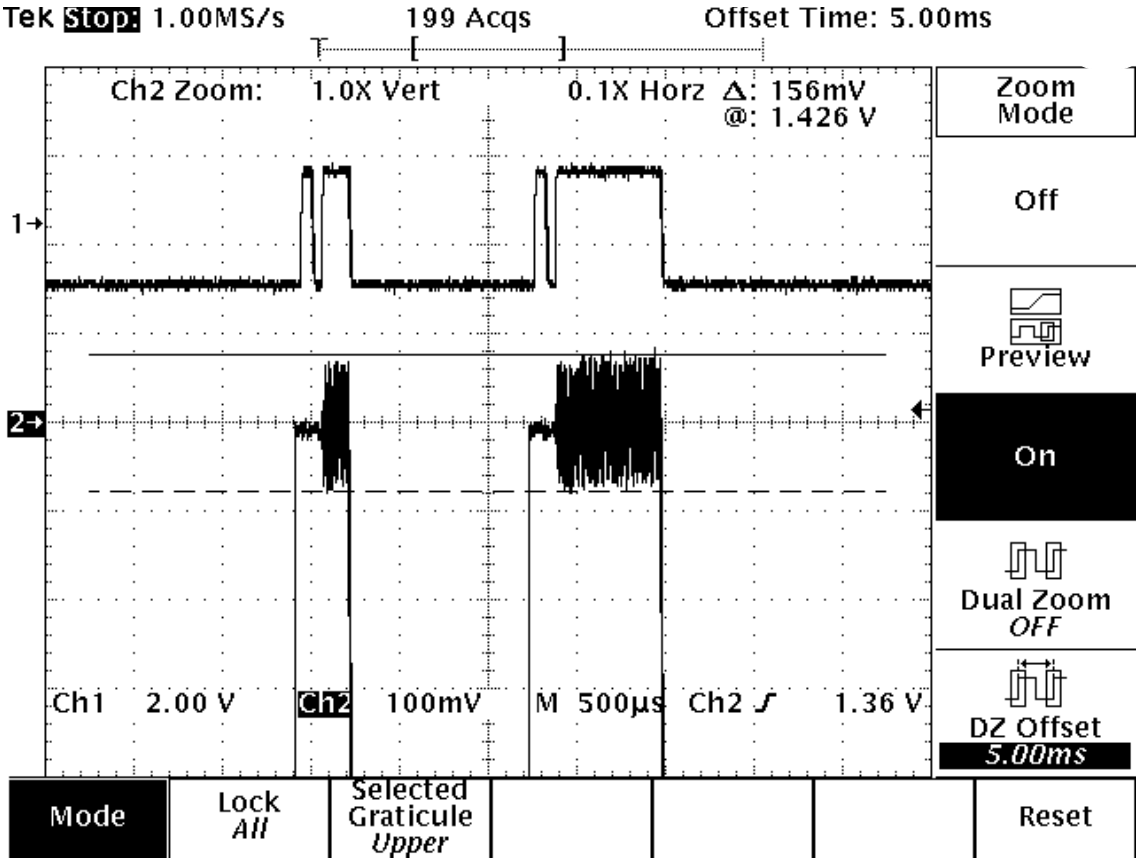

Figure 9, "GSM1900 Rx I or Q signal (trace2), burst mode." :

GSM1900 receiver burst mode I or Q signal at ch 661 with input signal 1960.067MHz, level –90 dBm at RF-connector.

Trace2: With wider time scaling both monitoring and own Rx bursts are seen, 1st burst (shorter) is monitoring and 2nd burst (longer) is own Rx burst.

Trace1: External LNA VCC supply voltage at burst mode, input level –90 dBm. Measured from test point LNA_VCC.

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Figure 10: Rx I&Q, phase difference 90 deg between signals.

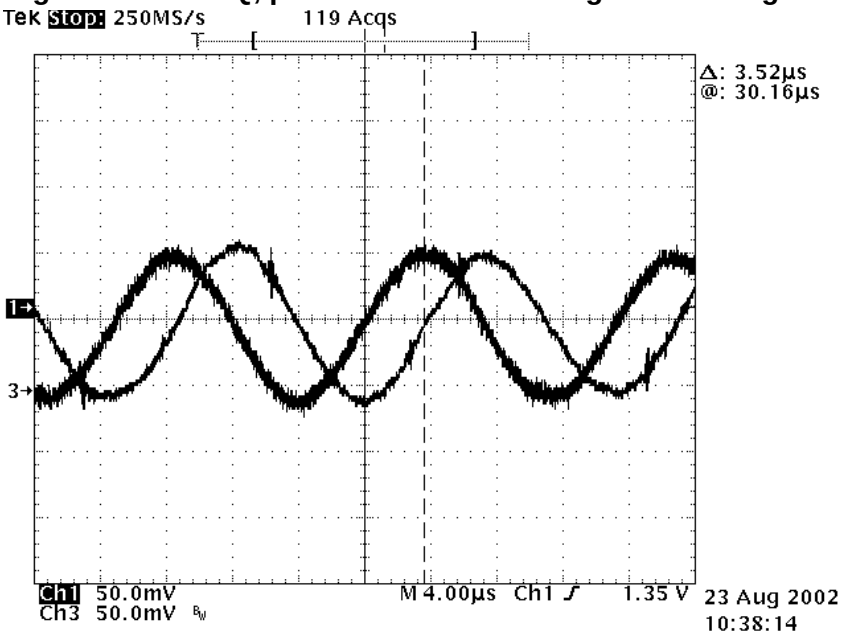

Figure 10, "Rx I&Q, phase difference 90 deg between signals." :

Detailed view of GSM850 continuous mode Rx I and Q signals measured from test points RXI and RXQ simultaneously.

Used channel 190, input signal 881.6671 MHz, level –90 dBm at antenna port, AGC setting 12.

Phase difference should be 90 degrees between Rx I and Q signals at all bands.

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5. Transmitter Description and Troubleshooting

The transmitter consists of two final frequency IQ-modulators and a power amplifier (separate ones for the lower and upper bands), and a power control loop. The IQ-modulators are integrated in Helgo, as well as the operational amplifiers of the power control loop. The two power amplifiers are located in a single module with a power detector. In the GMSK mode, the power is controlled by adjusting the DC bias levels of the power amplifiers.

Transmitter characteristics

Item	Values (GSM850/1800/1900)
Type	Direct conversion, nonlinear, FDMA/ TDMA
LO frequency range	3296...3396 MHz/3420...3570 MHz/ 3700...3820 MHz
Output power	GMSK 33/30/30 dBm 8-PSK 27/26/26 dBm
Gain control range	min. 30 dB
Phase error (RMS/peak), GMSK EVM (RMS/peak), 8-PSK	5 deg./20 deg. peak 10%/30%

Power amplifier

The power amplifier features include:

- 50 ohm input and output, GSM850/1800/1900
- internal power detector
- EDGE mode

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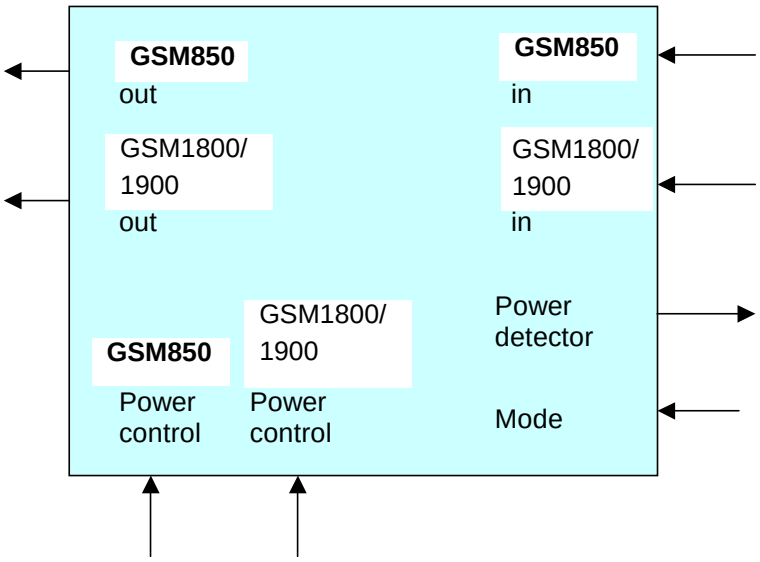
Figure 11:Power amplifier



RF ASIC Helgo

The RF ASIC features include:

- Package uBGA108
- Balanced I/Q demodulator and balanced I/Q modulator
- Power control operational amplifier, acting as an error amplifier
- Balanced signal from VCO, frequencies 3420 to 3980 MHz
- Integrated GSM850 and GSM1800 low noise amplifiers (LNAs)
- Helgo testing via test points only

AFC function

AFC is used to lock the transceiver's clock to the base station frequency.

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General instructions for Tx troubleshooting

For a description of the test setup, refer to the Service Software Section, Service Concept diagram.

1. Connect a test jig to the computer with a DAU-9S cable or to a FPS-8 flash prommer with an XCS-4 modular cable.

- Make sure that you have PKD-1 dongle connected to the computer's parallel port.

2. Connect a DC power supply to module test jig with a PCS-1 cable.

3. Set the DC supply voltage to 4.2V and set the jumper connector on test jig to "bypass" position.

Attention: When repairing or tuning transmitter use an external DC supply with at least 3A current capability.

4. Connect an RF cable to the module test jig's (MJS-13) RF connector and to measurement equipment or at least a 10dB attenuator, otherwise the PA may be damaged.

Use a spectrum analyzer as measurement equipment.

Attention: Normally Spectrum analyzer maximum input power is +30dBm. It is recommended to use 10dB attenuator on the spectrum analyzer input to prevent any damage.

5. Set the phone module to test jig and start Phoenix service software.

6. Initialize connection to the phone. (Use FBUS driver when using DAU-9S and COMBOX driver when using FPS-8).

7. Select product from the menu: File -> Choose Product -> NHL-12.

8. From the toolbar, set operating mode to "Local".

9. Activate the RF Controls window from the menu: Testing -> RF Controls.

In the RF Controls window:

- Select band "GSM850" or "GSM 1800" or "GSM1900" (Default = "GSM850").
- Set Active unit to "Tx" (Default = "Rx").
- Set Operation mode to "Burst" (Default = "Burst").
- Set Tx data type to "Random" (Default = "All1").
- Set Rx/Tx channel to 190 on GSM850 band or 700 on GSM1800 band or 661 on GSM1900 (Defaults).
- Set Tx PA mode to "Free" (Default).
- Set power level to 5 (Default = 19) on GSM850 or to 0 (Default = 15) on GSM1800 or GSM1900.

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Transmitter troubleshooting diagram

Figure 12:Transmitter troubleshooting

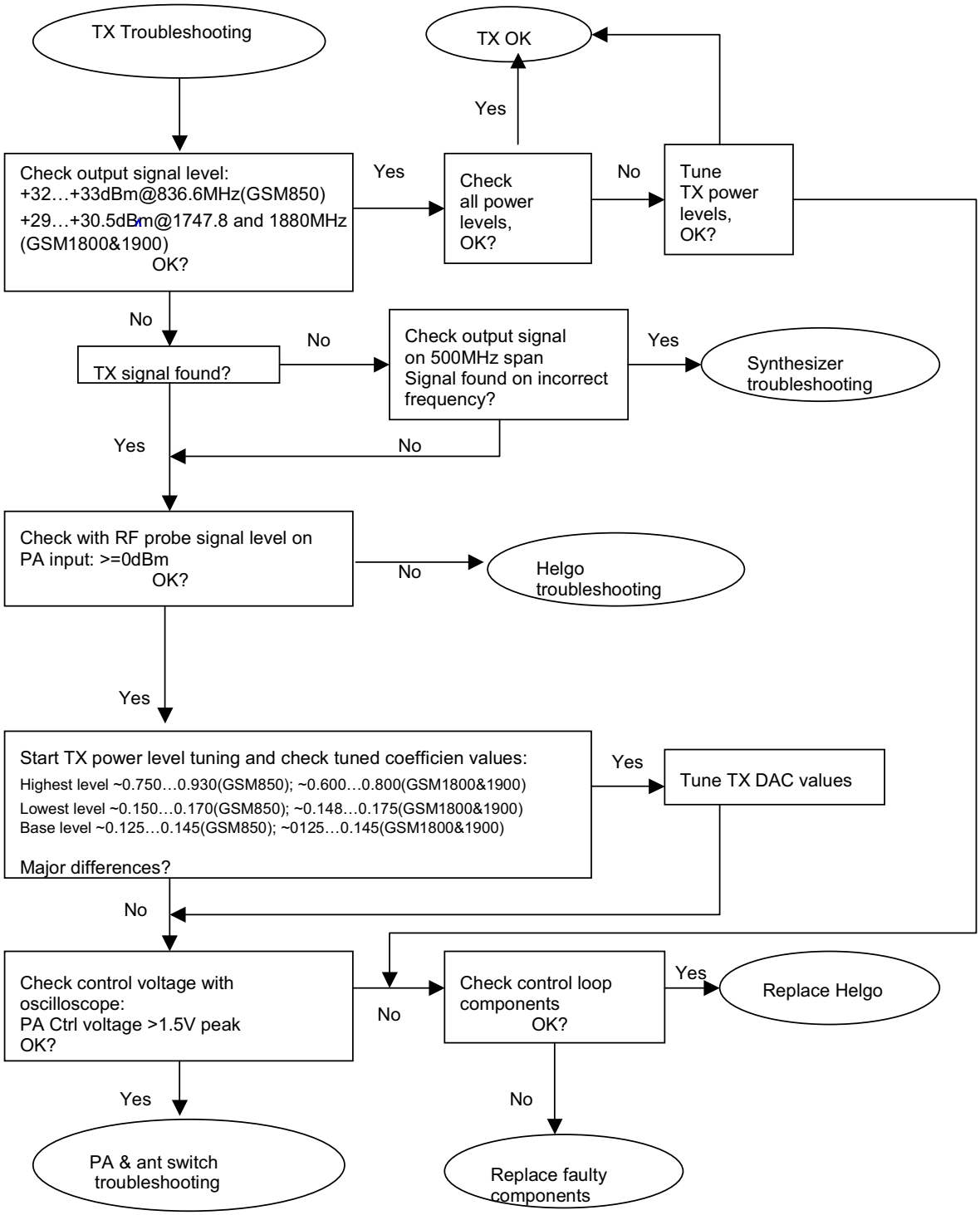

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Figure 13:Helgo IC troubleshooting

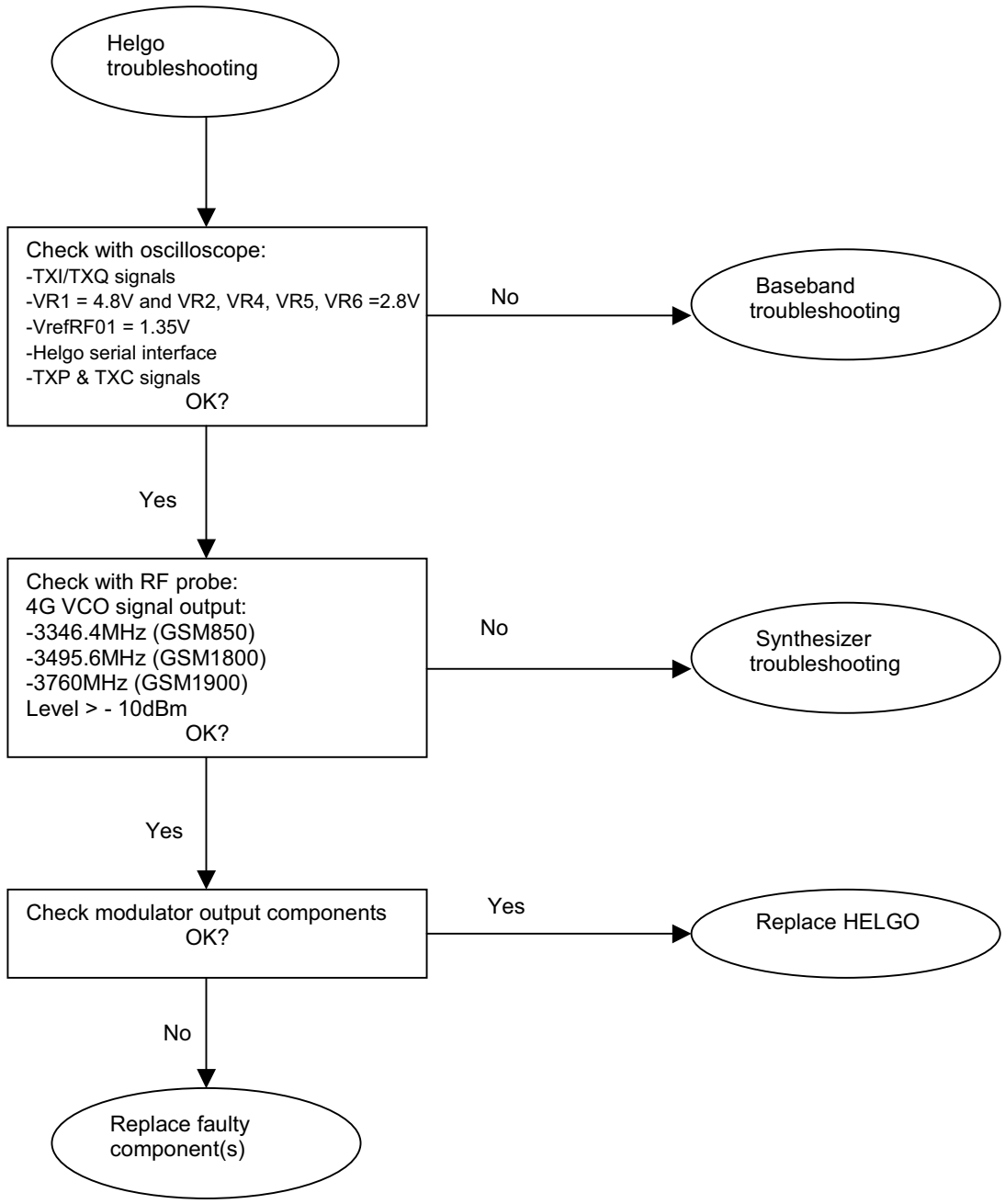

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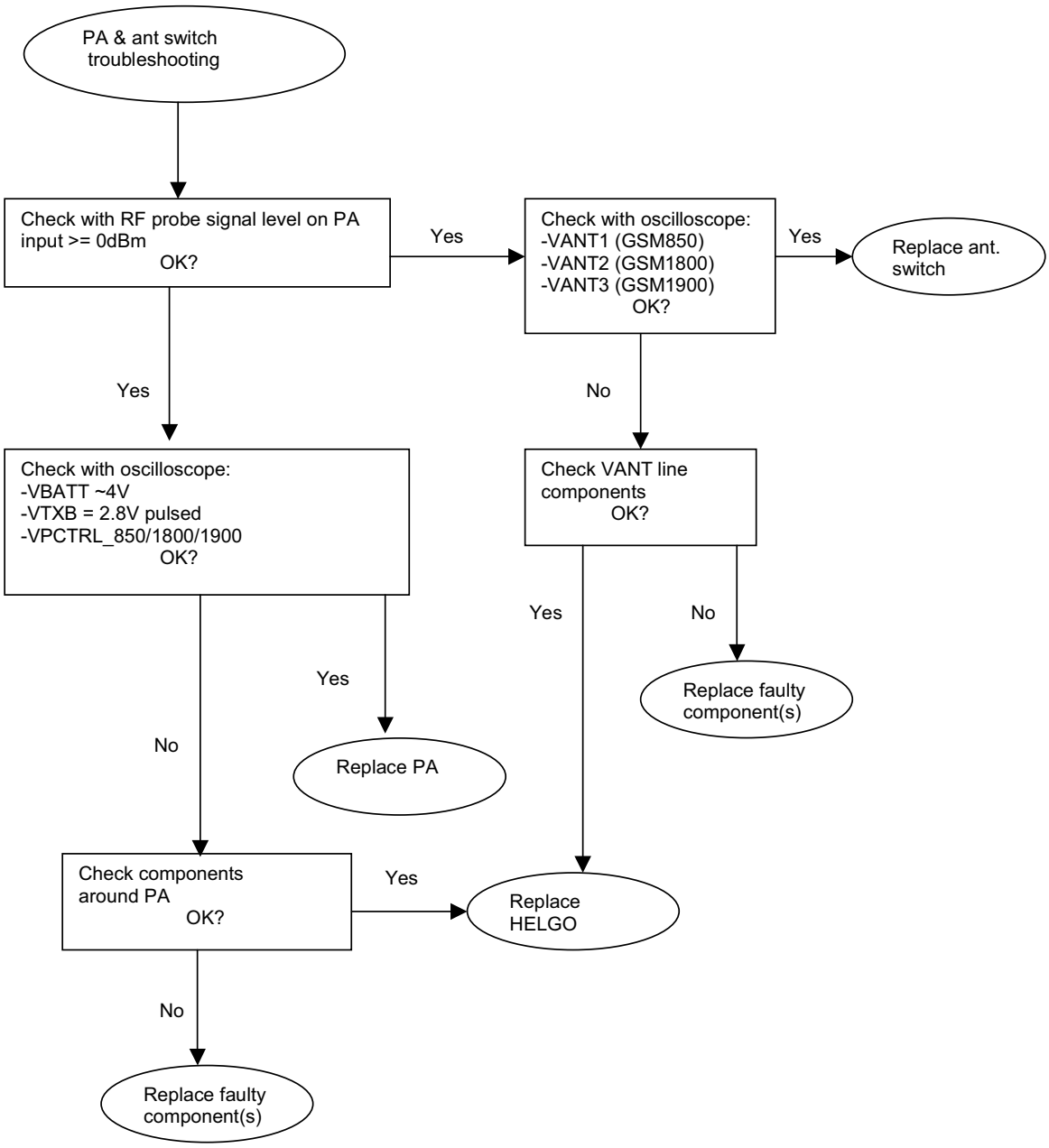
Figure 14:PA and antenna switch troubleshooting



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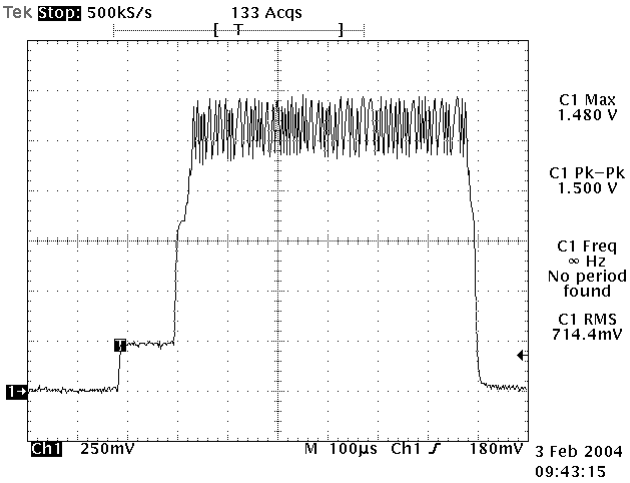
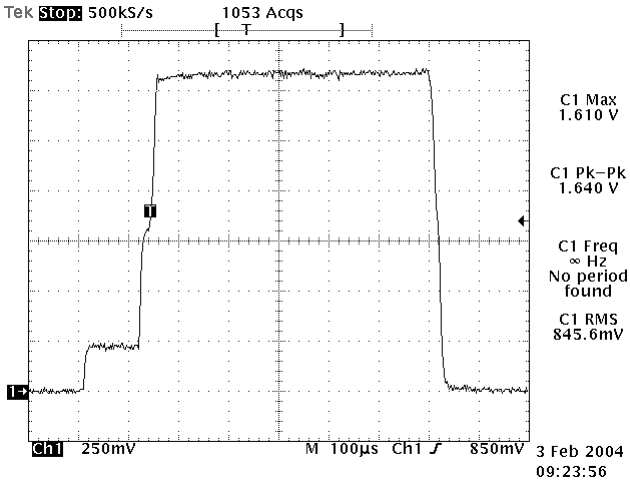
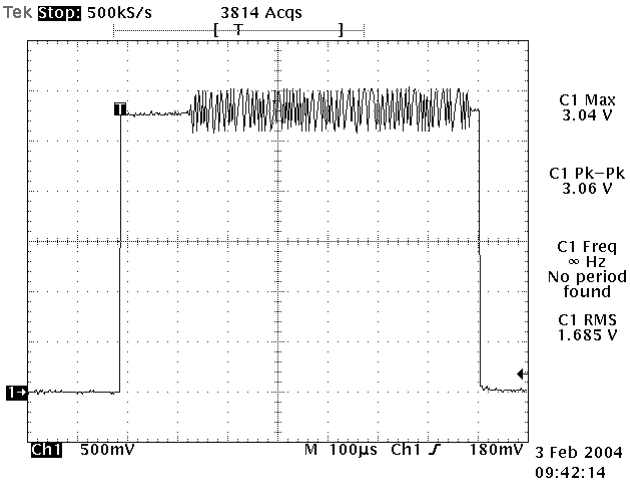
Pictures of transmitter signals



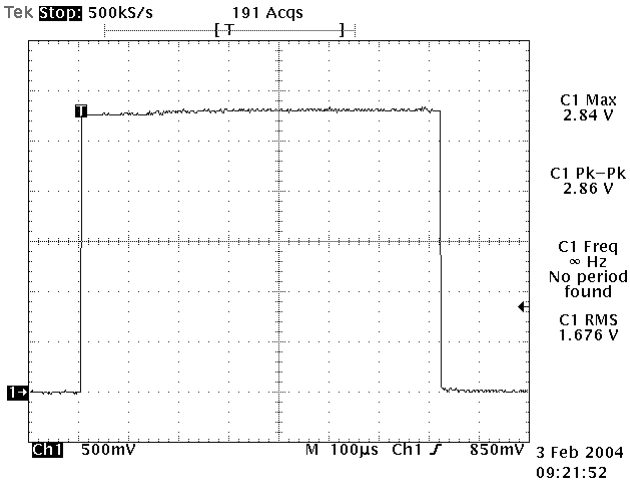
VPCTRL 850 at GSM850



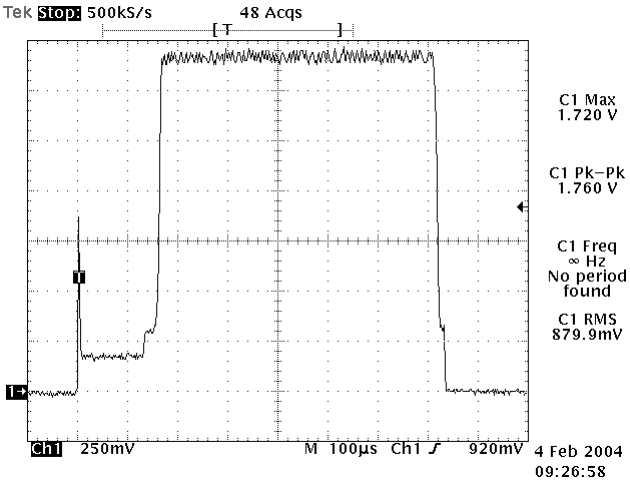
VPCTRL 1800/1900 at GSM1800



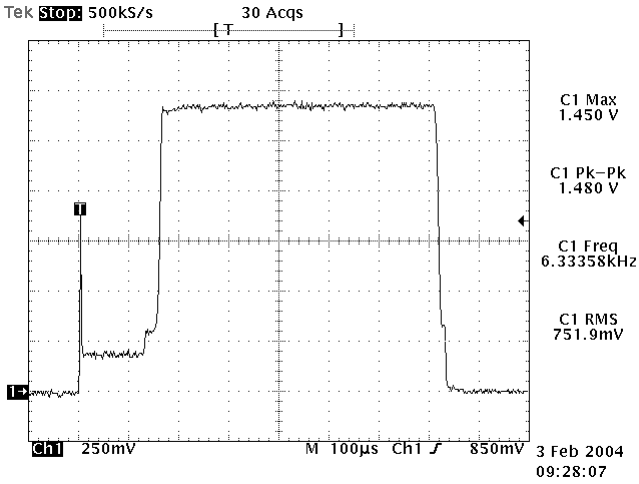
VTXB 850 at GSM850



VTXB 1800/1900 at GSM1800



TXC at GSM850



TXC at GSM1900

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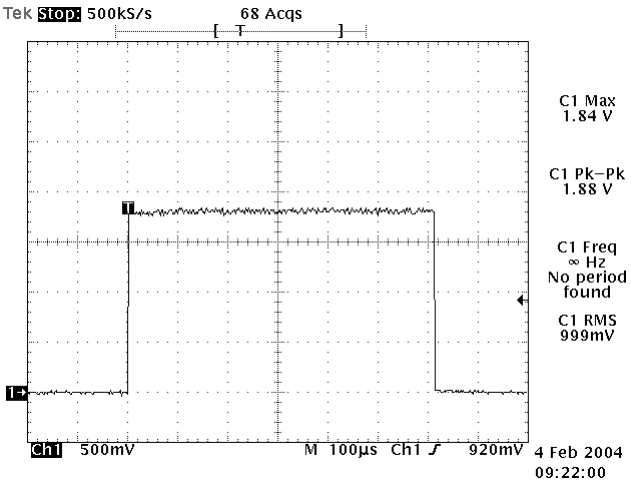
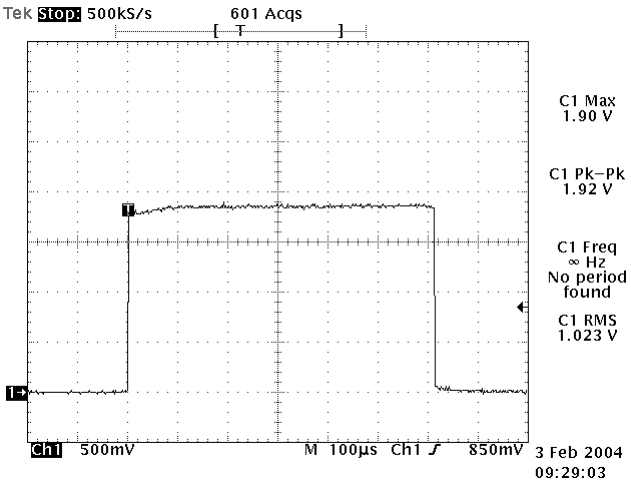
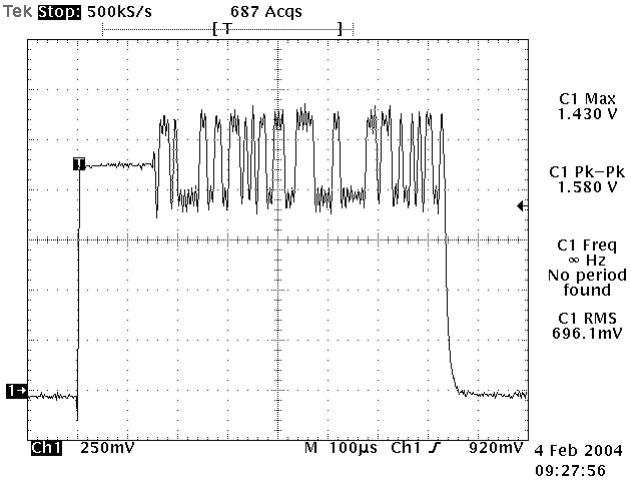


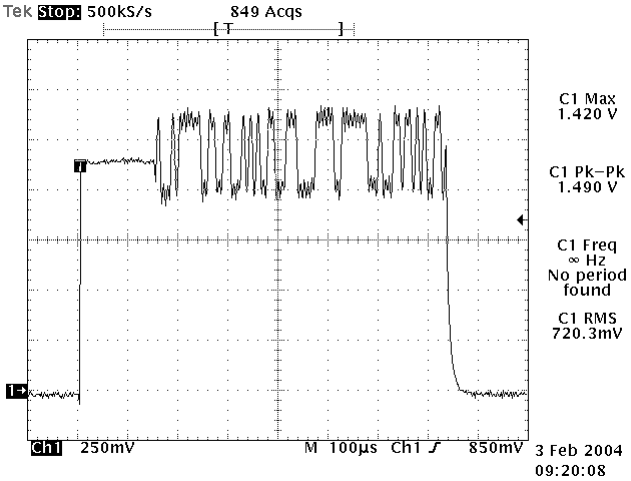
TXP at GSM850



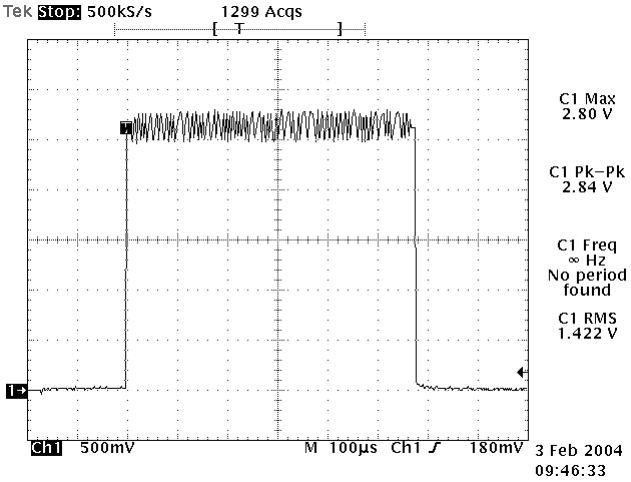
TXP at GSM1900



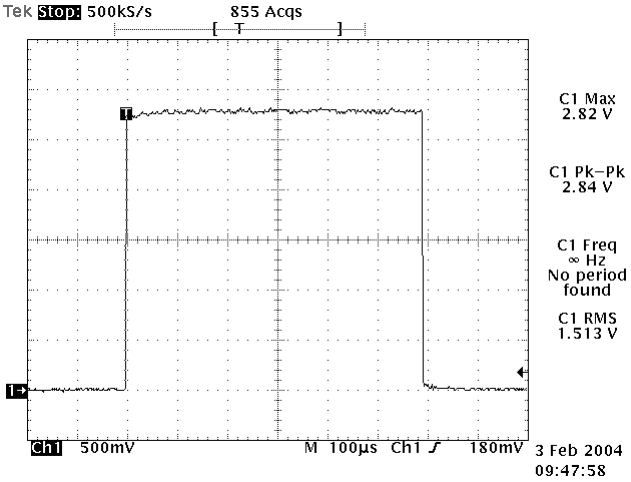
TX I/Q at GSM850



TX I/Q at GSM1800



VANT1 at GSM850 (TX)



VANT3 at GSM1900 (TX)

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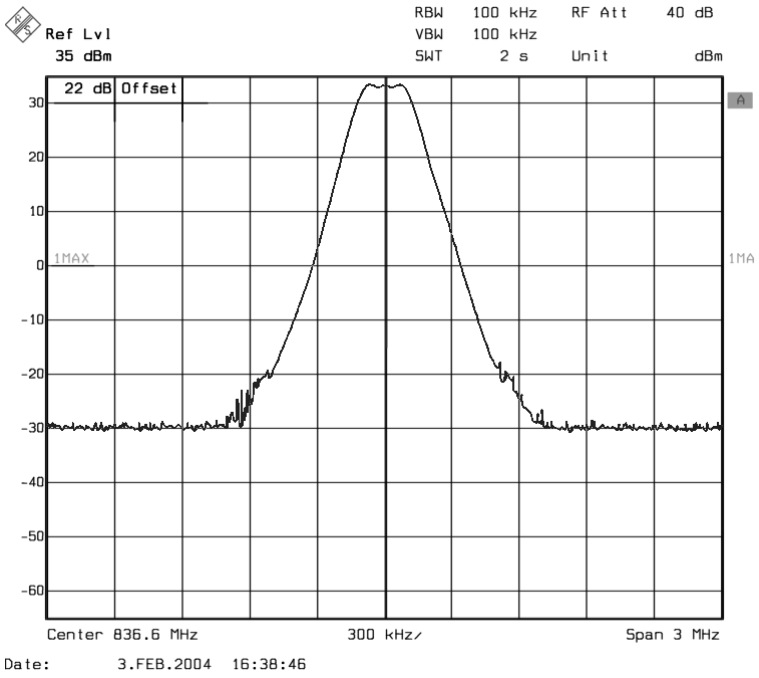

RFout at GSM850

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6. Additional Information on EDGE Troubleshooting

Note! EDGE mode troubleshooting differs slightly from basic GSM troubleshooting.

1. Establish connection to the phone normally (see GSM850/1800/1900 trouble-shooting instructions).
2. Select product from the menu: File -> Choose Product -> NHL-12.
3. From the toolbar, set operating mode to “Local”.
4. Activate the RF Controls window from the menu: Testing -> RF Controls.

In the RF Controls window:

- Select Band “GSM850” or “GSM1800” or “GSM1900” (Default=”GSM850”).
- Set Active unit to “Tx” (Default=”Rx”).
- Set Edge “On” (Default=”Off”).
- Set Operation mode to “Burst” (Default=”Burst”).
- Set Tx data type to “Alternate PN9” (Default=”All1”).

Note! In EDGE tuning, set data type to "All 0's". If you are using "Alternate PN9", you need to tune power levels 1dBm lower than the target levels.

- Set Rx/Tx channel to 190 on GSM850 or 700 on GSM1800 or 661 on GSM1900 (Defaults).
- Set power level to 8 (Default = 19) on GSM850 or to 2 (Default = 0) on GSM1800 or GSM1900.

NOTE! For GSM850 EDGE power levels 5, 6 and 7 are not in use and for GSM1800&1900 EDGE power levels 0 and 1 are not in use.

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Figure 15:Transmitter EDGE troubleshooting

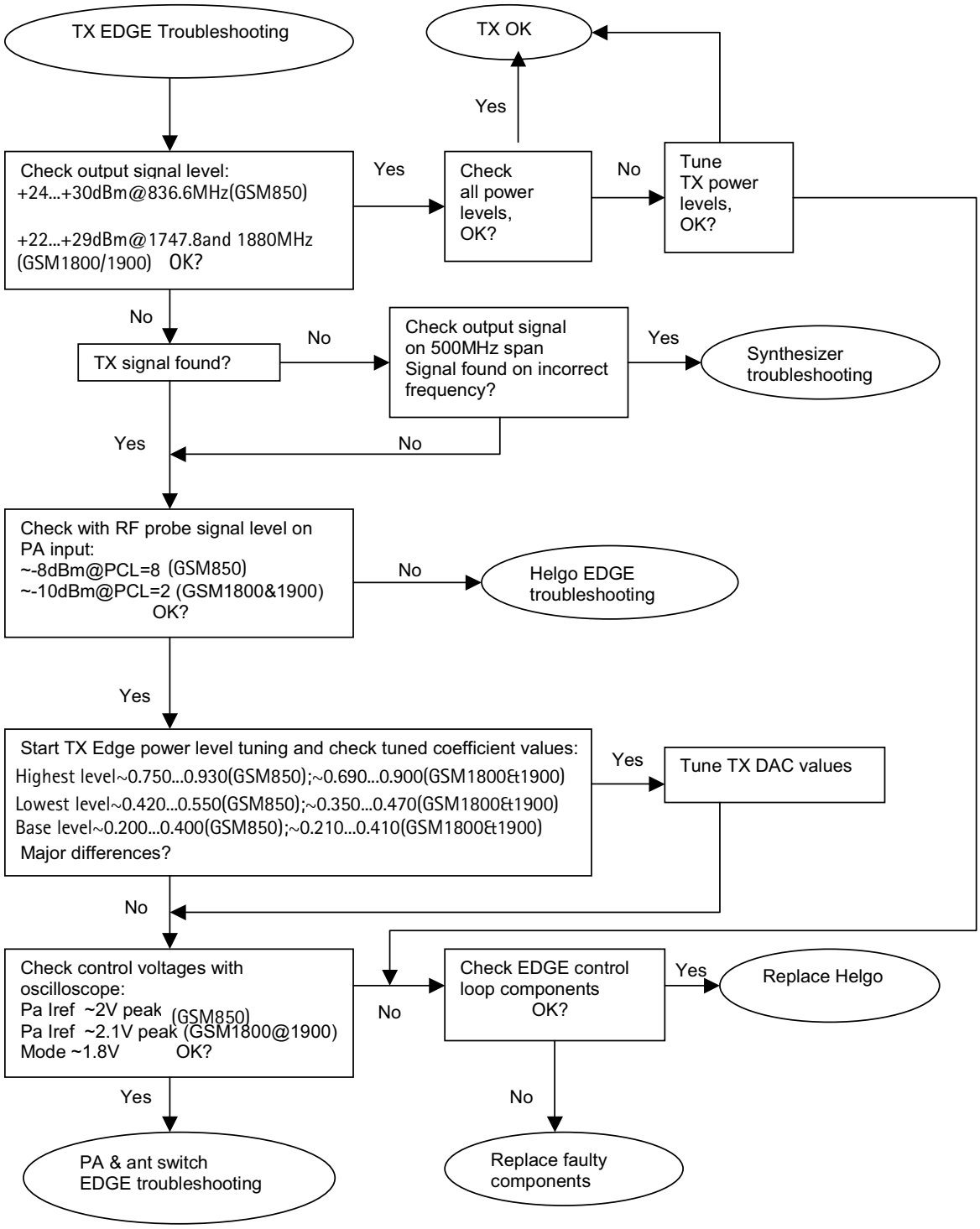

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Figure 16:Helgo EDGE troubleshooting

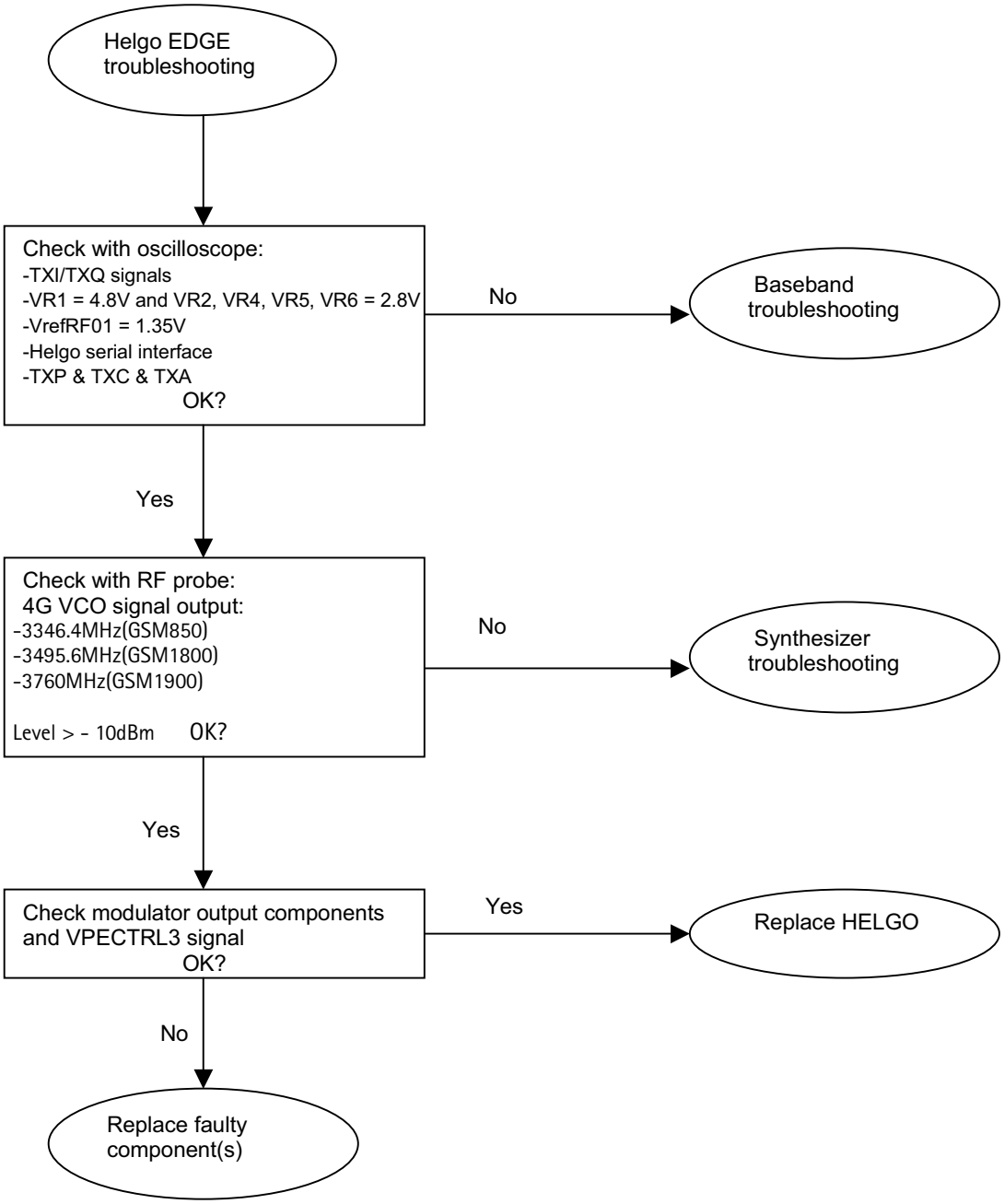

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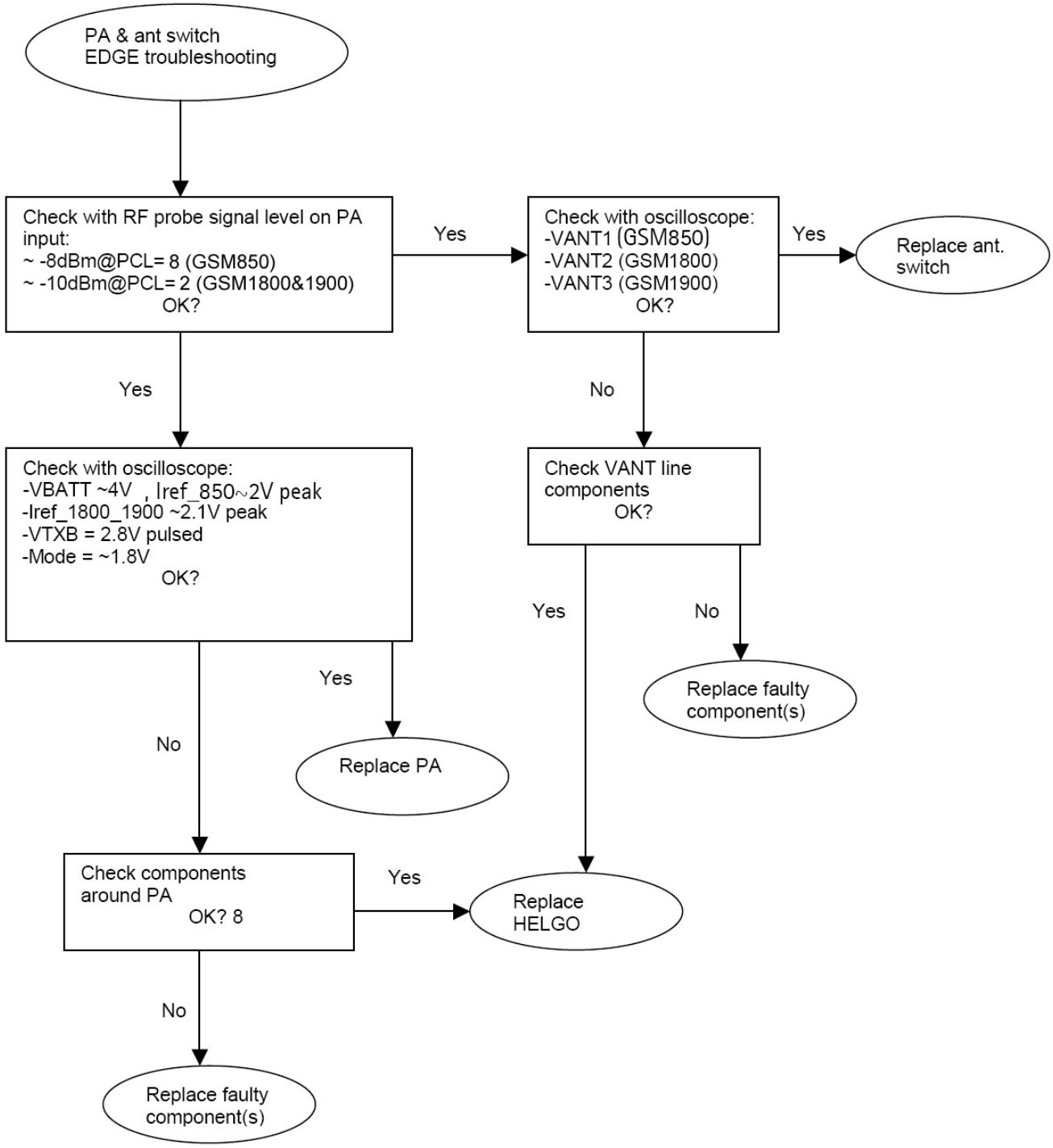
Figure 17:PA & ant switch EDGE troubleshooting



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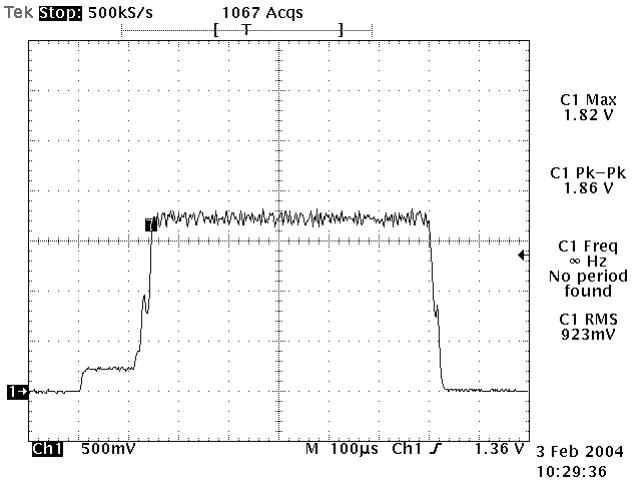
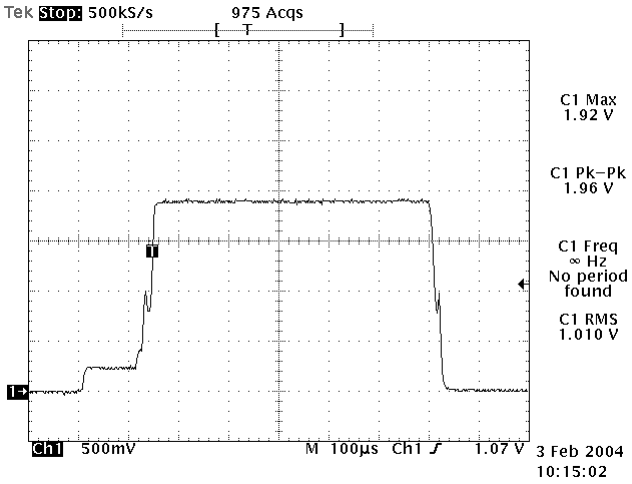
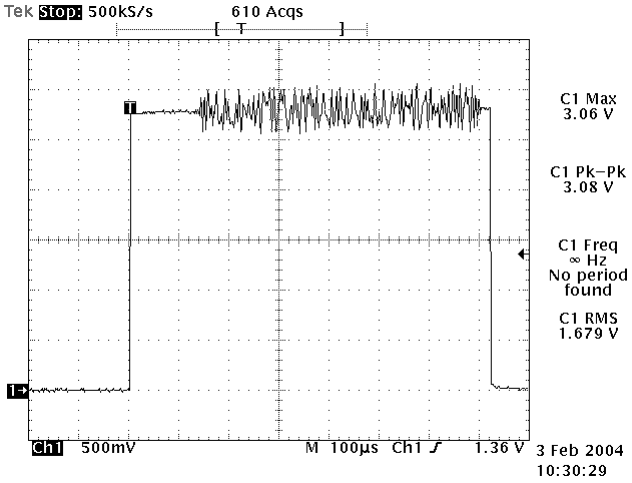
Pictures of EDGE transmitter signals


Tek Stop: 500kS/s 1067 Acqs
C1 Max 1.82 V
C1 Pk-Pk 1.86 V
C1 Freq ∞ Hz No period found
C1 RMS 923mV
Ch1 500mV M 100µs Ch1 ƒ 1.36 V
3 Feb 2004 10:29:36

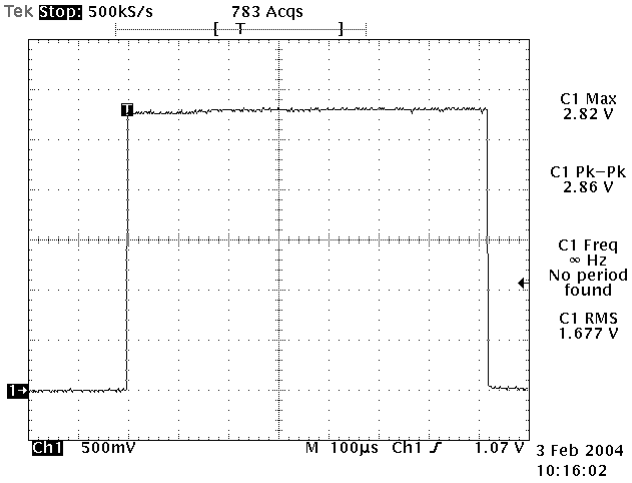
VPECTRL3 at EDGE850


Tek Stop: 500kS/s 975 Acqs
C1 Max 1.92 V
C1 Pk-Pk 1.96 V
C1 Freq ∞ Hz No period found
C1 RMS 1.010 V
Ch1 500mV M 100µs Ch1 ƒ 1.07 V
3 Feb 2004 10:15:02

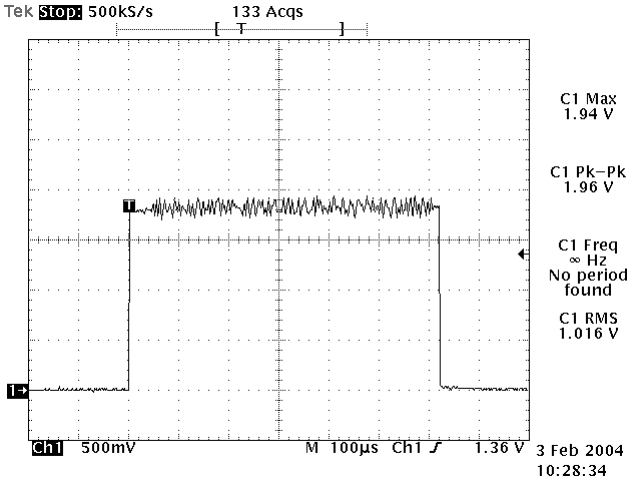
VPECTRL3 at EDGE1900


Tek Stop: 500kS/s 610 Acqs
C1 Max 3.06 V
C1 Pk-Pk 3.08 V
C1 Freq ∞ Hz No period found
C1 RMS 1.679 V
Ch1 500mV M 100µs Ch1 ƒ 1.36 V
3 Feb 2004 10:30:29

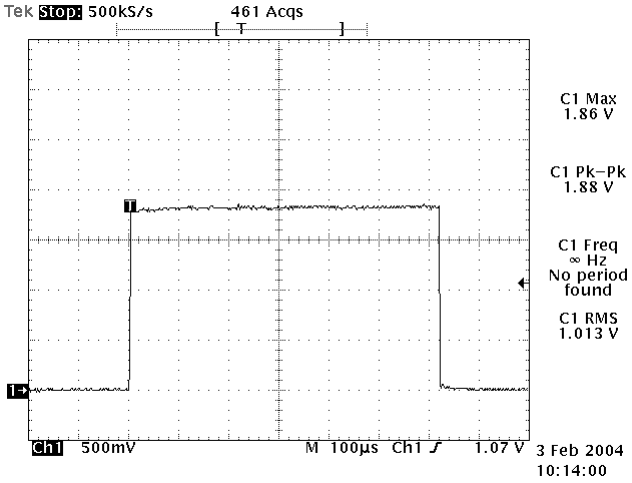
VTXB 850 at EDGE850


Tek Stop: 500kS/s 783 Acqs
C1 Max 2.82 V
C1 Pk-Pk 2.86 V
C1 Freq ∞ Hz No period found
C1 RMS 1.677 V
Ch1 500mV M 100µs Ch1 ƒ 1.07 V
3 Feb 2004 10:16:02

VTXB 1800/1900 at EDGE1900


Tek Stop: 500kS/s 133 Acqs
C1 Max 1.94 V
C1 Pk-Pk 1.96 V
C1 Freq ∞ Hz No period found
C1 RMS 1.016 V
Ch1 500mV M 100µs Ch1 ƒ 1.36 V
3 Feb 2004 10:28:34

Mode at EDGE850


Tek Stop: 500kS/s 461 Acqs
C1 Max 1.86 V
C1 Pk-Pk 1.88 V
C1 Freq ∞ Hz No period found
C1 RMS 1.013 V
Ch1 500mV M 100µs Ch1 ƒ 1.07 V
3 Feb 2004 10:14:00

Mode at EDGE1900

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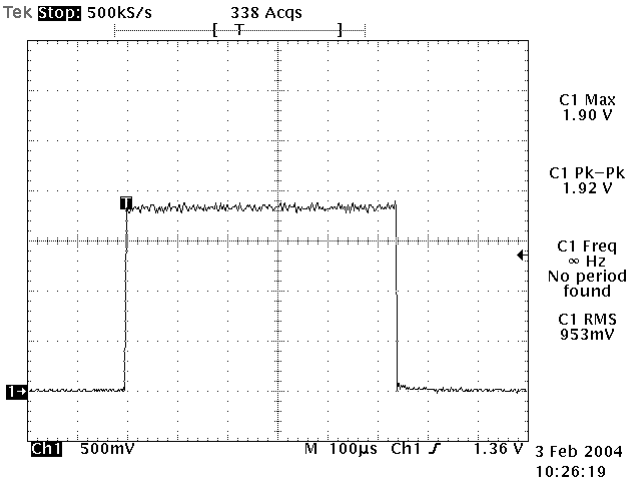
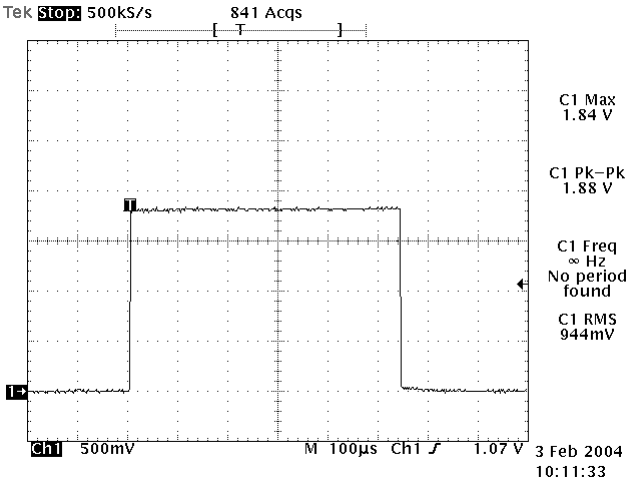
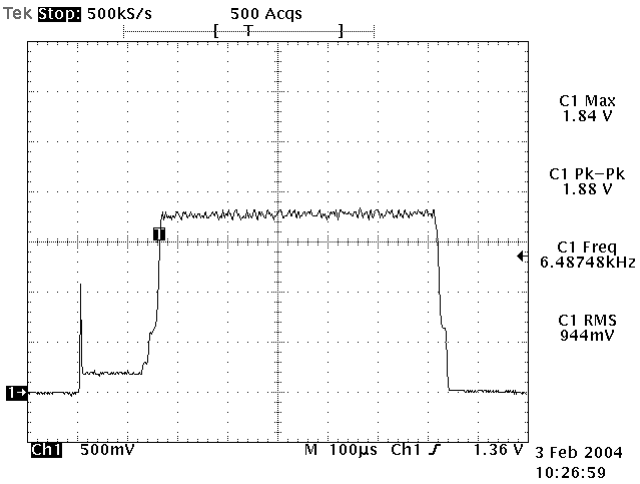


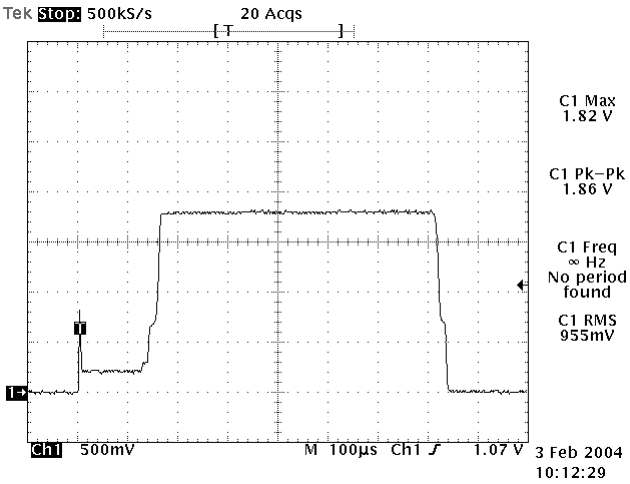
TXA at EDGE850



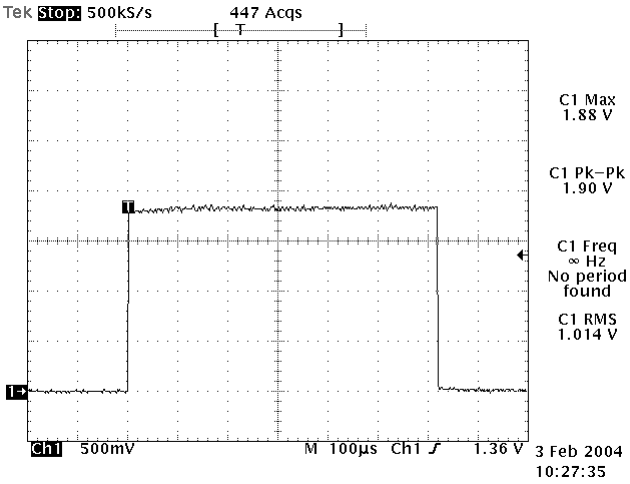
TXA at EDGE1900



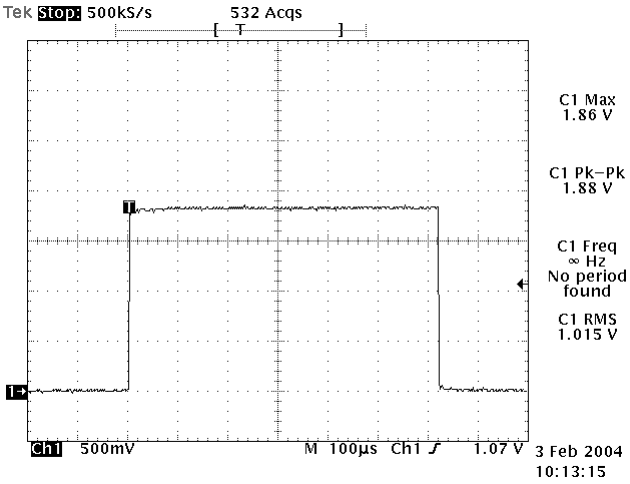
TXC at EDGE850



TXC at EDGE1900



TXP at EDGE850



TXP at EDGE1900

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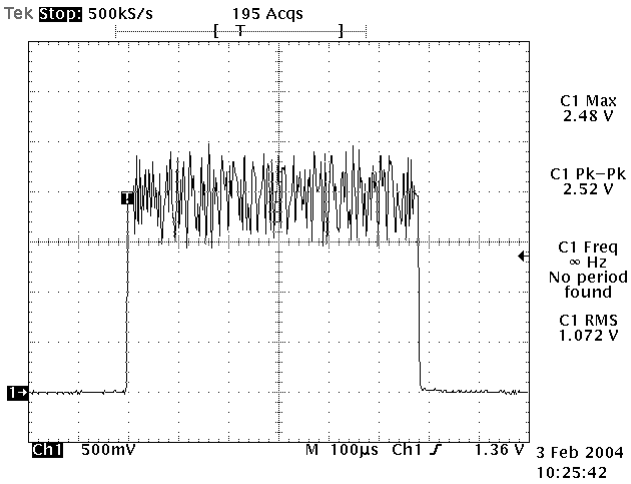
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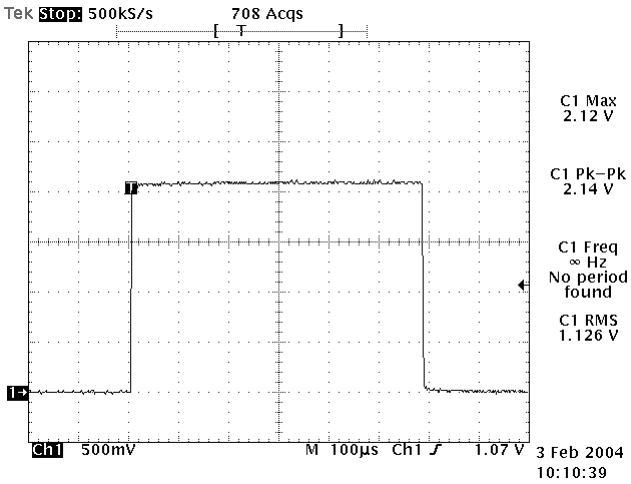
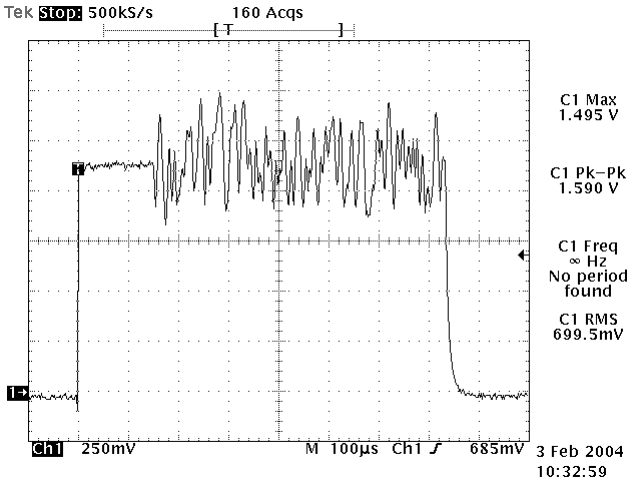
C1 Pk-Pk 2.52 V
C1 Freq ∞ Hz No period found
C1 RMS 1.072 V
Ch1 500mV M 100µs Ch1 ƒ 1.36 V
3 Feb 2004 10:25:42

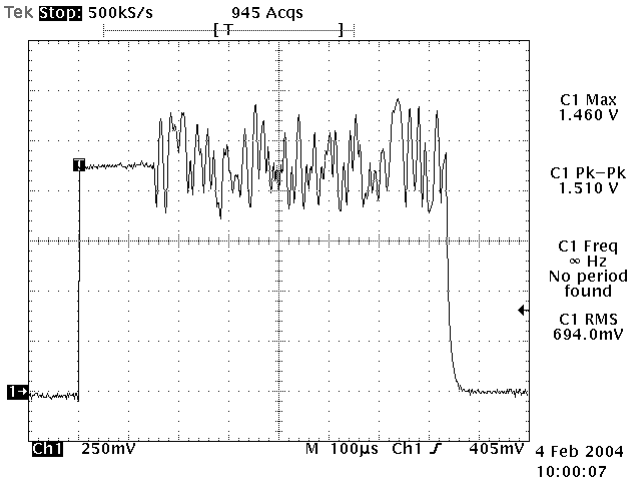
Iref 850 at EDGE850


Tek Stop: 500kS/s 708 Acqs
C1 Max 2.12 V
C1 Pk-Pk 2.14 V
C1 Freq ∞ Hz No period found
C1 RMS 1.126 V
Ch1 500mV M 100µs Ch1 ƒ 1.07 V
3 Feb 2004 10:10:39

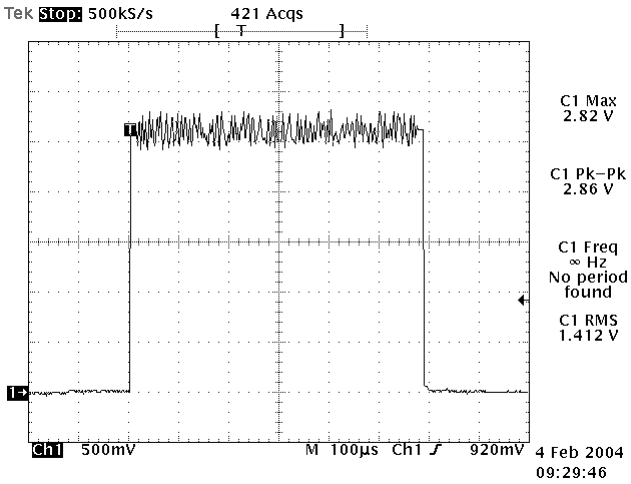
Iref 1800/1900 at EDGE1900


Tek Stop: 500kS/s 160 Acqs
C1 Max 1.495 V
C1 Pk-Pk 1.590 V
C1 Freq ∞ Hz No period found
C1 RMS 699.5mV
Ch1 250mV M 100µs Ch1 ƒ 685mV
3 Feb 2004 10:32:59

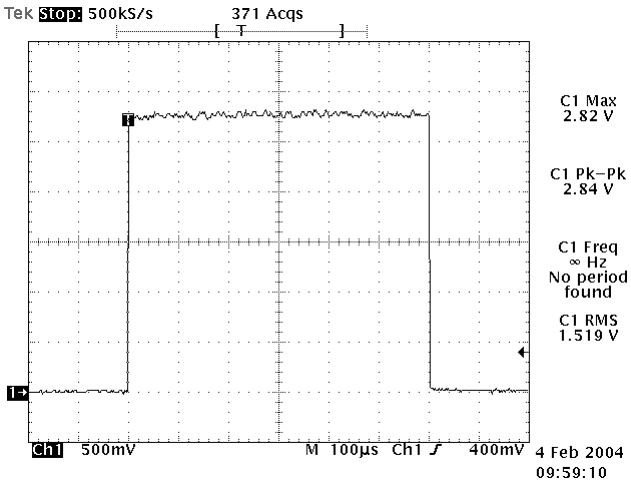
TX I/Q at EDGE850


Tek Stop: 500kS/s 945 Acqs
C1 Max 1.460 V
C1 Pk-Pk 1.510 V
C1 Freq ∞ Hz No period found
C1 RMS 694.0mV
Ch1 250mV M 100µs Ch1 ƒ 405mV
4 Feb 2004 10:00:07

TX I/Q at EDGE1900


Tek Stop: 500kS/s 421 Acqs
C1 Max 2.82 V
C1 Pk-Pk 2.86 V
C1 Freq ∞ Hz No period found
C1 RMS 1.412 V
Ch1 500mV M 100µs Ch1 ƒ 920mV
4 Feb 2004 09:29:46

VANT1 at EDGE850 (TX)


Tek Stop: 500kS/s 371 Acqs
C1 Max 2.82 V
C1 Pk-Pk 2.84 V
C1 Freq ∞ Hz No period found
C1 RMS 1.519 V
Ch1 500mV M 100µs Ch1 ƒ 400mV
4 Feb 2004 09:59:10

VANT3 at EDGE1900 (TX)

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7. Synthesizer Description and Troubleshooting

One PLL synthesizer is generating all the required frequencies for both Rx and Tx and for all three bands (GSM850/1800/1900).

Frequency synthesizers

The VCO frequency is locked by a PLL (phase locked loop) into a stable frequency source given by a VCTCXO which is running at 26 MHz. The frequency of the VCTCXO is in turn locked into the base station frequency with the help of an AFC voltage that is generated in the UEM by an 11 bit D/A converter. The PLL is located in Helgo and it is controlled through the RFBus.

The required frequency dividers for modulator and demodulator mixers are integrated in Helgo.

Loop filter filters out the comparison pulses of the phase detector and generates a DC control voltage to the VCO. The loop filter determines the step response of the PLL (settling time) and contributes to the stability of the loop.

The frequency synthesizer is integrated in Helgo except for the VCTCXO, VCO, and the loop filter.

Table 2: 26 MHz reference oscillator (VCTCXO)

Parameter	Min	Typ	Max	Unit/ Notes
Supply voltage, Vcc	2.60	2.70	2.80	V
Current consumption, Icc			1.5	mA
Operating temperature range	-30		+80	deg. C
Nominal frequency		26		MHz
Output voltage swing, Vcc=2.6V Temp=-20...+75deg. C (swing of the 26MHz component, a selective measurement from the spectrum)	0.8			Vpp
Load, resistance capacitance		2 10		kohm pF
Frequency tolerance @+25deg. C with internal frequency tuning no tuning	 -1.0 -10		 +1.0 +10	 ppm ppm
Frequency tolerance after reflow (@+25deg. C)	-1.0		+1.0	ppm
Frequency stability vs. temperature (ref. @+25, -20....+75deg. C)	-5.0		+5.0	ppm
Frequency stability vs. supply voltage (2.7V +/- 100mV)	-0.2		+0.2	ppm

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Table 2: 26 MHz reference oscillator (VCTCXO)

Parameter	Min	Typ	Max	Unit/ Notes
Frequency stability vs. load change (2kohm//10pF +/-10%)	-0.3		+0.3	ppm
Aging	-1.0		+1.0	ppm/ year
Control voltage, Vc	0.3	1.3	2.3	V
Control voltage slope, 0.3V<Vc<2.3V with internal frequency tuning no tuning.	 +/-9 +/-18		 +/-16 +/-30	 ppm/V ppm/V
Control input resistance	1			Mohm
Harmonics			-8	dBc
Duty Cycle	40		60	%, (T+)/ (Ttotal)
Start up time output level within 90% and output frequency limits +/-0.1ppm from the final value			5	ms
Frequency dips at any initial frequency Temp=-20...+75deg. C Vcc=2.6...2.8V Vc=0.3...2.3V	-0.5		0.5	ppm
Phase noise @1kHz offset			-130	dBc/Hz

Table 3: VCO

Parameter	Conditions	Min	Nom	Max	Unit
Supply voltage, Vcc		2.55	2.70	2.85	V
Current consumption, Icc				20	mA
Control voltage, Vc		0.7		3.8	V
Oscillation frequency	Vc=0.7V Vc=3.8V	 3980		3290	MHz MHz
Tuning voltage at the center frequency	f=3635MHz Vcc=2.7V Temp=+25C	2.0	2.25	2.5	V
Tuning voltage sensitivity in operating frequency range at each spot freq.		225	250	275	MHz/V

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Table 3: VCO

Parameter	Conditions	Min	Nom	Max	Unit
Output power level		-3.0			dBm
Output impedance VSWR			50	 2.0	ohm
Phase noise, fo +/- 25 kHz fo +/- 600 kHz fo +/- 1600 kHz fo +/- 3000 kHz fo +/- 20000 kHz				-90 -116 -126 -136 -152	dBc/Hz dBc/Hz dBc/Hz dBc/Hz dBc/Hz
Pulling figure	VSWR=2, any phase	-5.0		+5.0	MHz
Pushing figure	Vcc=2.7+/-0.15V	-1.5		+1.5	MHz
Frequency stability over temperature range	Temp=-10...+75deg. C	-15.0		+15.0	MHz
Harmonics				-15	dBc
Spurious levels				-70	dBc
Input capacitance at Vc-pin	Vc=0V			30	pF

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General instructions for synthesizer troubleshooting

Checking synthesizer operation

1. Connect a test jig to the computer with a DAU-9S cable or to a FPS-8 flash prommer with an XCS-4 modular cable.

• Make sure that you have a PKD-1 dongle connected to the computer's parallel port.

2. Connect a DC power supply or FPS-8 to the module test jig with a PCS-1 cable.

3. Set the DC supply voltage to 3.9V and set the jumper connector on test jig to "bypass" position.

4. Set the phone module to test jig and start Phoenix service software

5. Initialize connection to the phone. (Use FBUS driver when using DAU-9S and COMBOX driver when using FPS-8).

6. Select product from the menu: File -> Choose Product -> NHL-12.

7. From the toolbar, set operating mode to "Local".

8. Activate the RF Controls window from the menu: Testing -> RF Controls

In the RF Controls window:

- Select band "GSM850", "GSM 1800" or "GSM1900" (Default = "GSM850").
- Set Active unit to "Rx" (Default = "Rx").
- Set Operation mode to "Continuous" (Default = "Burst").
- Set Rx/Tx channel to 190 on GSM850 band, 700 on GSM1800 band, 661 on GSM1900 band (Defaults).

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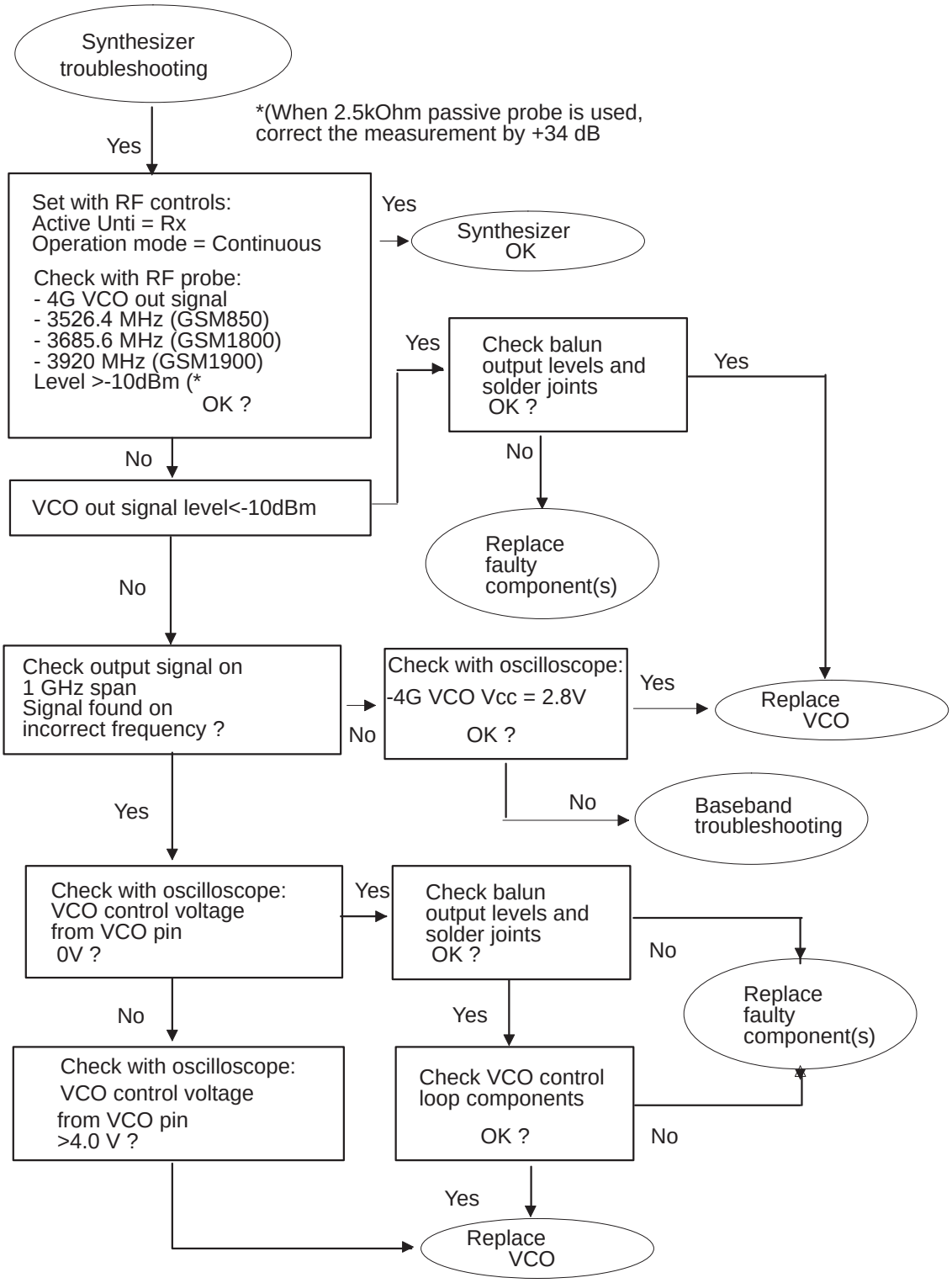
Troubleshooting chart for PLL synthesizer

Figure 18:Frequency synthesizer troubleshooting



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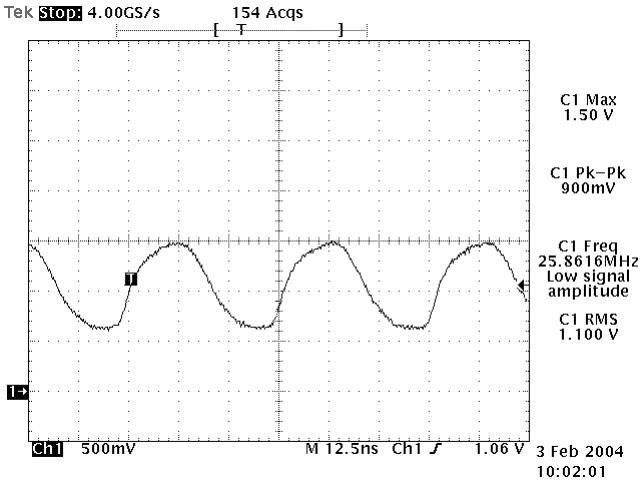
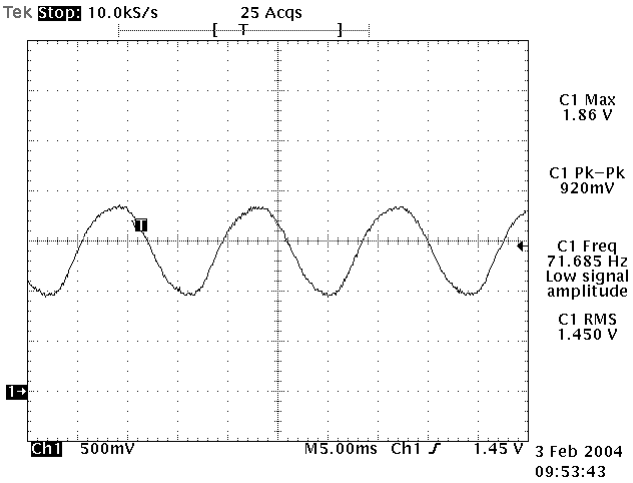
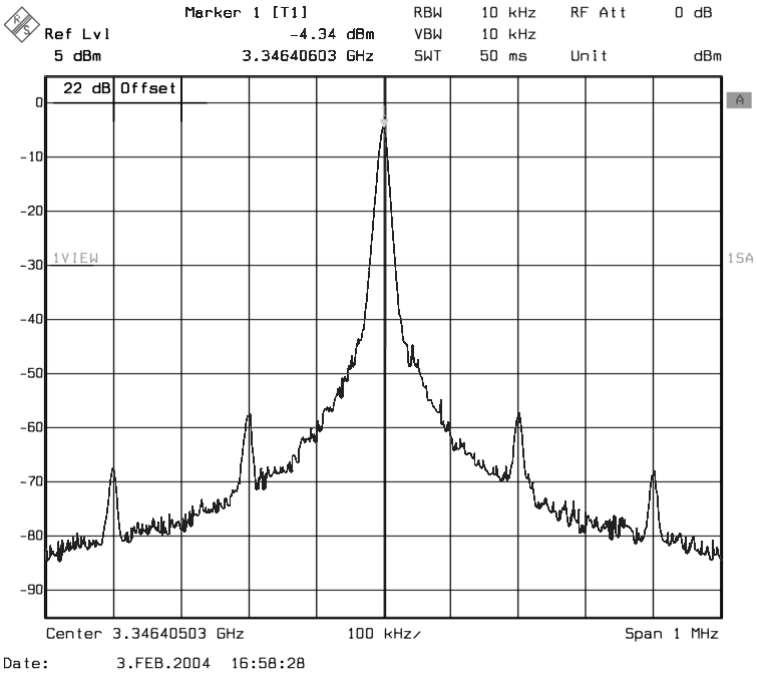
Pictures of synthesizer signals



VCTCXO at GSM1900 (RX)



Clk to BB at GSM1900 (RX)



VCO out at GSM850 (TX)

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Frequency lists

GSM850

CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
128	824.2	869.2	3296.8	3476.8	170	832.6	877.6	3330.4	3510.4	212	841.0	886.0	3364.0	3544.0
129	824.4	869.4	3297.6	3477.6	171	832.8	877.8	3331.2	3511.2	213	841.2	886.2	3364.8	3544.8
130	824.6	869.6	3298.4	3478.4	172	833.0	878.0	3332.0	3512.0	214	841.4	886.4	3365.6	3545.6
131	824.8	869.8	3299.2	3479.2	173	833.2	878.2	3332.8	3512.8	215	841.6	886.6	3366.4	3546.4
132	825.0	870.0	3300.0	3480.0	174	833.4	878.4	3333.6	3513.6	216	841.8	886.8	3367.2	3547.2
133	825.2	870.2	3300.8	3480.8	175	833.6	878.6	3334.4	3514.4	217	842.0	887.0	3368.0	3548.0
134	825.4	870.4	3301.6	3481.6	176	833.8	878.8	3335.2	3515.2	218	842.2	887.2	3368.8	3548.8
135	825.6	870.6	3302.4	3482.4	177	834.0	879.0	3336.0	3516.0	219	842.4	887.4	3369.6	3549.6
136	825.8	870.8	3303.2	3483.2	178	834.2	879.2	3336.8	3516.8	220	842.6	887.6	3370.4	3550.4
137	826.0	871.0	3304.0	3484.0	179	834.4	879.4	3337.6	3517.6	221	842.8	887.8	3371.2	3551.2
138	826.2	871.2	3304.8	3484.8	180	834.6	879.6	3338.4	3518.4	222	843.0	888.0	3372.0	3552.0
139	826.4	871.4	3305.6	3485.6	181	834.8	879.8	3339.2	3519.2	223	843.2	888.2	3372.8	3552.8
140	826.6	871.6	3306.4	3486.4	182	835.0	880.0	3340.0	3520.0	224	843.4	888.4	3373.6	3553.6
141	826.8	871.8	3307.2	3487.2	183	835.2	880.2	3340.8	3520.8	225	843.6	888.6	3374.4	3554.4
142	827.0	872.0	3308.0	3488.0	184	835.4	880.4	3341.6	3521.6	226	843.8	888.8	3375.2	3555.2
143	827.2	872.2	3308.8	3488.8	185	835.6	880.6	3342.4	3522.4	227	844.0	889.0	3376.0	3556.0
144	827.4	872.4	3309.6	3489.6	186	835.8	880.8	3343.2	3523.2	228	844.2	889.2	3376.8	3556.8
145	827.6	872.6	3310.4	3490.4	187	836.0	881.0	3344.0	3524.0	229	844.4	889.4	3377.6	3557.6
146	827.8	872.8	3311.2	3491.2	188	836.2	881.2	3344.8	3524.8	230	844.6	889.6	3378.4	3558.4
147	828.0	873.0	3312.0	3492.0	189	836.4	881.4	3345.6	3525.6	231	844.8	889.8	3379.2	3559.2
148	828.2	873.2	3312.8	3492.8	190	836.6	881.6	3346.4	3526.4	232	845.0	890.0	3380.0	3560.0
149	828.4	873.4	3313.6	3493.6	191	836.8	881.8	3347.2	3527.2	233	845.2	890.2	3380.8	3560.8
150	828.6	873.6	3314.4	3494.4	192	837.0	882.0	3348.0	3528.0	234	845.4	890.4	3381.6	3561.6
151	828.8	873.8	3315.2	3495.2	193	837.2	882.2	3348.8	3528.8	235	845.6	890.6	3382.4	3562.4
152	829.0	874.0	3316.0	3496.0	194	837.4	882.4	3349.6	3529.6	236	845.8	890.8	3383.2	3563.2
153	829.2	874.2	3316.8	3496.8	195	837.6	882.6	3350.4	3530.4	237	846.0	891.0	3384.0	3564.0
154	829.4	874.4	3317.6	3497.6	196	837.8	882.8	3351.2	3531.2	238	846.2	891.2	3384.8	3564.8
155	829.6	874.6	3318.4	3498.4	197	838.0	883.0	3352.0	3532.0	239	846.4	891.4	3385.6	3565.6
156	829.8	874.8	3319.2	3499.2	198	838.2	883.2	3352.8	3532.8	240	846.6	891.6	3386.4	3566.4
157	830.0	875.0	3320.0	3500.0	199	838.4	883.4	3353.6	3533.6	241	846.8	891.8	3387.2	3567.2
158	830.2	875.2	3320.8	3500.8	200	838.6	883.6	3354.4	3534.4	242	847.0	892.0	3388.0	3568.0
159	830.4	875.4	3321.6	3501.6	201	838.8	883.8	3355.2	3535.2	243	847.2	892.2	3388.8	3568.8
160	830.6	875.6	3322.4	3502.4	202	839.0	884.0	3356.0	3536.0	244	847.4	892.4	3389.6	3569.6
161	830.8	875.8	3323.2	3503.2	203	839.2	884.2	3356.8	3536.8	245	847.6	892.6	3390.4	3570.4
162	831.0	876.0	3324.0	3504.0	204	839.4	884.4	3357.6	3537.6	246	847.8	892.8	3391.2	3571.2
163	831.2	876.2	3324.8	3504.8	205	839.6	884.6	3358.4	3538.4	247	848.0	893.0	3392.0	3572.0
164	831.4	876.4	3325.6	3505.6	206	839.8	884.8	3359.2	3539.2	248	848.2	893.2	3392.8	3572.8
165	831.6	876.6	3326.4	3506.4	207	840.0	885.0	3360.0	3540.0	249	848.4	893.4	3393.6	3573.6
166	831.8	876.8	3327.2	3507.2	208	840.2	885.2	3360.8	3540.8	250	848.6	893.6	3394.4	3574.4
167	832.0	877.0	3328.0	3508.0	209	840.4	885.4	3361.6	3541.6	251	848.8	893.8	3395.2	3575.2
168	832.2	877.2	3328.8	3508.8	210	840.6	885.6	3362.4	3542.4					
169	832.4	877.4	3329.6	3509.6	211	840.8	885.8	3363.2	3543.2					

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GSM1800

CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
512	1710.2	1805.2	3420.4	3610.4	606	1729.0	1824.0	3458.0	3648.0	700	1747.8	1842.8	3495.6	3685.6	794	1766.6	1861.6	3533.2	3723.2
513	1710.4	1805.4	6841.6	7221.6	607	1729.2	1824.2	3458.4	3648.4	701	1748.0	1843.0	3496.0	3686.0	795	1766.8	1861.8	3533.6	3723.6
514	1710.6	1805.6	6842.4	7222.4	608	1729.4	1824.4	3458.8	3648.8	702	1748.2	1843.2	3496.4	3686.4	796	1767.0	1862.0	3534.0	3724.0
515	1710.8	1805.8	6843.2	7223.2	609	1729.6	1824.6	3459.2	3649.2	703	1748.4	1843.4	3496.8	3686.8	797	1767.2	1862.2	3534.4	3724.4
516	1711.0	1806.0	6844.0	7224.0	610	1729.8	1824.8	3459.6	3649.6	704	1748.6	1843.6	3497.2	3687.2	798	1767.4	1862.4	3534.8	3724.8
517	1711.2	1806.2	6844.8	7224.8	611	1730.0	1825.0	3460.0	3650.0	705	1748.8	1843.8	3497.6	3687.6	799	1767.6	1862.6	3535.2	3725.2
518	1711.4	1806.4	6845.6	7225.6	612	1730.2	1825.2	3460.4	3650.4	706	1749.0	1844.0	3498.0	3688.0	800	1767.8	1862.8	3535.6	3725.6
519	1711.6	1806.6	6846.4	7226.4	613	1730.4	1825.4	3460.8	3650.8	707	1749.2	1844.2	3498.4	3688.4	801	1768.0	1863.0	3536.0	3726.0
520	1711.8	1806.8	6847.2	7227.2	614	1730.6	1825.6	3461.2	3651.2	708	1749.4	1844.4	3498.8	3688.8	802	1768.2	1863.2	3536.4	3726.4
521	1712.0	1807.0	6848.0	7228.0	615	1730.8	1825.8	3461.6	3651.6	709	1749.6	1844.6	3499.2	3689.2	803	1768.4	1863.4	3536.8	3726.8
522	1712.2	1807.2	6848.8	7228.8	616	1731.0	1826.0	3462.0	3652.0	710	1749.8	1844.8	3499.6	3689.6	804	1768.6	1863.6	3537.2	3727.2
523	1712.4	1807.4	6849.6	7229.6	617	1731.2	1826.2	3462.4	3652.4	711	1750.0	1845.0	3500.0	3690.0	805	1768.8	1863.8	3537.6	3727.6
524	1712.6	1807.6	6850.4	7230.4	618	1731.4	1826.4	3462.8	3652.8	712	1750.2	1845.2	3500.4	3690.4	806	1769.0	1864.0	3538.0	3728.0
525	1712.8	1807.8	6851.2	7231.2	619	1731.6	1826.6	3463.2	3653.2	713	1750.4	1845.4	3500.8	3690.8	807	1769.2	1864.2	3538.4	3728.4
526	1713.0	1808.0	6852.0	7232.0	620	1731.8	1826.8	3463.6	3653.6	714	1750.6	1845.6	3501.2	3691.2	808	1769.4	1864.4	3538.8	3728.8
527	1713.2	1808.2	6852.8	7232.8	621	1732.0	1827.0	3464.0	3654.0	715	1750.8	1845.8	3501.6	3691.6	809	1769.6	1864.6	3539.2	3729.2
528	1713.4	1808.4	6853.6	7233.6	622	1732.2	1827.2	3464.4	3654.4	716	1751.0	1846.0	3502.0	3692.0	810	1769.8	1864.8	3539.6	3729.6
529	1713.6	1808.6	6854.4	7234.4	623	1732.4	1827.4	3464.8	3654.8	717	1751.2	1846.2	3502.4	3692.4	811	1770.0	1865.0	3540.0	3730.0
530	1713.8	1808.8	6855.2	7235.2	624	1732.6	1827.6	3465.2	3655.2	718	1751.4	1846.4	3502.8	3692.8	812	1770.2	1865.2	3540.4	3730.4
531	1714.0	1809.0	6856.0	7236.0	625	1732.8	1827.8	3465.6	3655.6	719	1751.6	1846.6	3503.2	3693.2	813	1770.4	1865.4	3540.8	3730.8
532	1714.2	1809.2	6856.8	7236.8	626	1733.0	1828.0	3466.0	3656.0	720	1751.8	1846.8	3503.6	3693.6	814	1770.6	1865.6	3541.2	3731.2
533	1714.4	1809.4	6857.6	7237.6	627	1733.2	1828.2	3466.4	3656.4	721	1752.0	1847.0	3504.0	3694.0	815	1770.8	1865.8	3541.6	3731.6
534	1714.6	1809.6	6858.4	7238.4	628	1733.4	1828.4	3466.8	3656.8	722	1752.2	1847.2	3504.4	3694.4	816	1771.0	1866.0	3542.0	3732.0
535	1714.8	1809.8	6859.2	7239.2	629	1733.6	1828.6	3467.2	3657.2	723	1752.4	1847.4	3504.8	3694.8	817	1771.2	1866.2	3542.4	3732.4
536	1715.0	1810.0	6860.0	7240.0	630	1733.8	1828.8	3467.6	3657.6	724	1752.6	1847.6	3505.2	3695.2	818	1771.4	1866.4	3542.8	3732.8
537	1715.2	1810.2	6860.8	7240.8	631	1734.0	1829.0	3468.0	3658.0	725	1752.8	1847.8	3505.6	3695.6	819	1771.6	1866.6	3543.2	3733.2
538	1715.4	1810.4	6861.6	7241.6	632	1734.2	1829.2	3468.4	3658.4	726	1753.0	1848.0	3506.0	3696.0	820	1771.8	1866.8	3543.6	3733.6
539	1715.6	1810.6	6862.4	7242.4	633	1734.4	1829.4	3468.8	3658.8	727	1753.2	1848.2	3506.4	3696.4	821	1772.0	1867.0	3544.0	3734.0
540	1715.8	1810.8	6863.2	7243.2	634	1734.6	1829.6	3469.2	3659.2	728	1753.4	1848.4	3506.8	3696.8	822	1772.2	1867.2	3544.4	3734.4
541	1716.0	1811.0	6864.0	7244.0	635	1734.8	1829.8	3469.6	3659.6	729	1753.6	1848.6	3507.2	3697.2	823	1772.4	1867.4	3544.8	3734.8
542	1716.2	1811.2	6864.8	7244.8	636	1735.0	1830.0	3470.0	3660.0	730	1753.8	1848.8	3507.6	3697.6	824	1772.6	1867.6	3545.2	3735.2
543	1716.4	1811.4	6865.6	7245.6	637	1735.2	1830.2	3470.4	3660.4	731	1754.0	1849.0	3508.0	3698.0	825	1772.8	1867.8	3545.6	3735.6
544	1716.6	1811.6	6866.4	7246.4	638	1735.4	1830.4	3470.8	3660.8	732	1754.2	1849.2	3508.4	3698.4	826	1773.0	1868.0	3546.0	3736.0
545	1716.8	1811.8	6867.2	7247.2	639	1735.6	1830.6	3471.2	3661.2	733	1754.4	1849.4	3508.8	3698.8	827	1773.2	1868.2	3546.4	3736.4
546	1717.0	1812.0	6868.0	7248.0	640	1735.8	1830.8	3471.6	3661.6	734	1754.6	1849.6	3509.2	3699.2	828	1773.4	1868.4	3546.8	3736.8
547	1717.2	1812.2	6868.8	7248.8	641	1736.0	1831.0	3472.0	3662.0	735	1754.8	1849.8	3509.6	3699.6	829	1773.6	1868.6	3547.2	3737.2
548	1717.4	1812.4	6869.6	7249.6	642	1736.2	1831.2	3472.4	3662.4	736	1755.0	1850.0	3510.0	3700.0	830	1773.8	1868.8	3547.6	3737.6
549	1717.6	1812.6	6870.4	7250.4	643	1736.4	1831.4	3472.8	3662.8	737	1755.2	1850.2	3510.4	3700.4	831	1774.0	1869.0	3548.0	3738.0
550	1717.8	1812.8	6871.2	7251.2	644	1736.6	1831.6	3473.2	3663.2	738	1755.4	1850.4	3510.8	3700.8	832	1774.2	1869.2	3548.4	3738.4
551	1718.0	1813.0	6872.0	7252.0	645	1736.8	1831.8	3473.6	3663.6	739	1755.6	1850.6	3511.2	3701.2	833	1774.4	1869.4	3548.8	3738.8
552	1718.2	1813.2	6872.8	7252.8	646	1737.0	1832.0	3474.0	3664.0	740	1755.8	1850.8	3511.6	3701.6	834	1774.6	1869.6	3549.2	3739.2
553	1718.4	1813.4	6873.6	7253.6	647	1737.2	1832.2	3474.4	3664.4	741	1756.0	1851.0	3512.0	3702.0	835	1774.8	1869.8	3549.6	3739.6
554	1718.6	1813.6	6874.4	7254.4	648	1737.4	1832.4	3474.8	3664.8	742	1756.2	1851.2	3512.4	3702.4	836	1775.0	1870.0	3550.0	3740.0
555	1718.8	1813.8	6875.2	7255.2	649	1737.6	1832.6	3475.2	3665.2	743	1756.4	1851.4	3512.8	3702.8	837	1775.2	1870.2	3550.4	3740.4
556	1719.0	1814.0	6876.0	7256.0	650	1737.8	1832.8	3475.6	3665.6	744	1756.6	1851.6	3513.2	3703.2	838	1775.4	1870.4	3550.8	3740.8
557	1719.2	1814.2	6876.8	7256.8	651	1738.0	1833.0	3476.0	3666.0	745	1756.8	1851.8	3513.6	3703.6	839	1775.6	1870.6	3551.2	3741.2
558	1719.4	1814.4	6877.6	7257.6	652	1738.2	1833.2	3476.4	3666.4	746	1757.0	1852.0	3514.0	3704.0	840	1775.8	1870.8	3551.6	3741.6
559	1719.6	1814.6	6878.4	7258.4	653	1738.4	1833.4	3476.8	3666.8	747	1757.2	1852.2	3514.4	3704.4	841	1776.0	1871.0	3552.0	3742.0
560	1719.8	1814.8	6879.2	7259.2	654	1738.6	1833.6	3477.2	3667.2	748	1757.4	1852.4	3514.8	3704.8	842	1776.2	1871.2	3552.4	3742.4
561	1720.0	1815.0	6880.0	7260.0	655	1738.8	1833.8	3477.6	3667.6	749	1757.6	1852.6	3515.2	3705.2	843	1776.4	1871.4	3552.8	3742.8
562	1720.2	1815.2	6880.8	7260.8	656	1739.0	1834.0	3478.0	3668.0	750	1757.8	1852.8	3515.6	3705.6	844	1776.6	1871.6	3553.2	3743.2
563	1720.4	1815.4	6881.6	7261.6	657	1739.2	1834.2	3478.4	3668.4	751	1758.0	1853.0	3516.0	3706.0	845	1776.8	1871.8	3553.6	3743.6
564	1720.6	1815.6	6882.4	7262.4	658	1739.4	1834.4	3478.8	3668.8	752	1758.2	1853.2	3516.4	3706.4	846	1777.0	1872.0	3554.0	3744.0
565	1720.8	1815.8	6883.2	7263.2	659	1739.6	1834.6	3479.2	3669.2	753	1758.4	1853.4	3516.8	3706.8	847	1777.2	1872.2	3554.4	3744.4
566	1721.0	1816.0	6884.0	7264.0	660	1739.8	1834.8	3479.6	3669.6	754	1758.6	1853.6	3517.2	3707.2	848	1777.4	1872.4	3554.8	3744.8
567	1721.2	1816.2	6884.8	7264.8	661	1740.0	1835.0	3480.0	3670.0	755	1758.8	1853.8	3517.6	3707.6	849	1777.6	1872.6	3555.2	3745.2
568	1721.4	1816.4	6885.6	7265.6	662	1740.2	1835.2	3480.4	3670.4	756	1759.0	1854.0	3518.0	3708.0	850	1777.8	1872.8	3555.6	3745.6
569	1721.6	1816.6	6886.4	7266.4	663	1740.4	1835.4	3480.8	3670.8	757	1759.2	1854.2	3518.4	3708.4	851	1778.0	1873.0	3556.0	3746.0
570	1721.8	1816.8	6887.2	7267.2	664	1740.6	1835.6	3481.2	3671.2	758	1759.4	1854.4	3518.8	3708.8	852	1778.2	1873.2	3556.4	3746.4
571	1722.0	1817.0	6888.0	7268.0	665	1740.8	1835.8	3481.6	3671.6	759	1759.6	1854.6	3519.2	3709.2	853	1778.4	1873.4	3556.8	3746.8
572	1722.2	1817.2	6888.8	7268.8	666	1741.0	1836.0	3482.0	3672.0	760	1759.8	1854.8	3519.6	3709.6	854	1778.6	1873.6	3557.2	3747.2
573	1722.4	1817.4	6889.6	7269.6	667	1741.2	1836.2	3482.4	3672.4	761	1760.0	1855.0	3520.0	3710.0	855	1778.8	1873.8	3557.6	3747.6
574	1722.6	1817.6	6890.4	7270.4	668	1741.4	1836.4	3482.8	3672.8	762	1760.2	1855.2	3520.4	3710.4	856	1779.0	1874.0	3558.0	3748.0
575	1722,8	1817,8	6891,2	7271,2	669	1741,6	1836,6	3483,2	3673,2	763	1760,4	1855,4	3520,8	3710,8	857	1779,2	1874,2	3558,4	3748,4
576	1723,0	1818,0	6892,0	7272,0	670	1741,8	1836,8	3483,6	3673,6	764	1760,6	1855,6	3521,2	3711,2	858	1779,4	1874,4	3558,8	3748,8
577	1723,2	1818,2	6892,8	7272,8	671	1742,0	1837,0	3484,0	3674,0	765	1760,8	1855,8	3521,6	3711,6	859	1779,6	1874,6	3559,2	3749,2
578	1723,4	1818,4	6893,6	7273,6	672	1742,2	1837,2	3484,4	3674,4	766	1761,0	1856,0	3522,0	3712,0	860	1779,8	1874,8	3559,6	3749,6
579	1723,6	1818,6	6894,4	7274,4	673	1742,4	1837,4	3484,8	3674,8	767	1761,2	1856,2	3522,4	3712,4	861	1780,0	1875,0	3560,0	3750,0
580	1723,8	1818,8	6895,2	7275,2	674	1742,6	1837,6	3485,2	3675,2	768	1761,4	1856,4	3522,8	3712,8	862	1780,2	1875,2	3560,4	3750,4
581	1724,0	1819,0	6896,0	7276,0	675	1742,8	1837,8	3485,6	3675,6	769	1761,6	1856,6	3523,2	3713,2	863	1780,4	1875,4	3560,8	3750,8
582	1724,2	1819,2	6896,8	7276,8	676	1743,0	1838,0	3486,0	3676,0	770	1761,8	1856,8	3523,6	3713,6	864	1780,6	1875,6	3561,2	3751,2
583	1724,4	1819,4	6897,6	7277,6	677	1743,2	1838,2	3486,4	3676,4	771	1762,0	1857,0	3524,0	3714,0	865	1780,8	1875,8	3561,6	3751,6
584	1724,6	1819,6	6898,4	7278,4	678	1743,4	1838,4	3486,8	3676,8	772	1762,2	1857,2	3524,4	3714,4	866	1781,0	1876,0	3562,0	3752,0
585	1724,8	1819,8	6899,2	7279,2	679	1743,6	1838,6	3487,2	3677,2	773	1762,4	1857,4	3524,8	3714,8	867	1781,2	1876,2	3562,4	3752,4
586	1725,0	1820,0	6900,0	7280,0	680	1743,8	1838,8	3487,6	3677,6	774	1762,6	1857,6	3525,2	3715,2	868	1781,4	1876,4	3562,8	3752,8
587	1725,2	1820,2	6900,8	7280,8	681	1744,0	1839,0	3488,0	3678,0	775	1762,8	1857,8	3525,6	3715,6	869	1781,6	1876,6	3563,2	3753,2
588	1725,4	1820,4	6901,6	7281,6	682	1744,2	1839,2	3488,4	3678,4	776	1763,0	1858,0	3526,0	3716,0	870	1781,8	1876,8	3563,6	3753,6
589	1725,6	1820,6	6902,4	7282,4	683	1744,4	1839,4	3488,8	3678,8	777	1763,2	1858,2	3526,4	3716,4	871	1782,0	1877,0	3564,0	3754,0
590	1725,8	1820,8	6903,2	7283,2	684	1744,6	1839,6	3489,2	3679,2	778	1763,4	1858,4	3526,8	3716,8	872	1782,2	1877,2	3564,4	3754,4
591	1726,0	1821,0	6904,0	7284,0	685	1744,8	1839,8	3489,6	3679,6	779	1763,6	1858,6	3527,2	3717,2	873	1782,4	1877,4	3564,8	3754,8
592	1726,2	1821,2	6904,8	7284,8	686	1745,0	1840,0	3490,0	3680,0	780	1763,8	1858,8	3527,6	3717,6	874	1782,6	1877,6	3565,2	3755,2
593	1726,4	1821,4	6905,6	7285,6	687	1745,2	1840,2	3490,4	3680,4	781	1764,0	1859,0	3528,0	3718,0	875	1782,8	1877,8	3565,6	3755,6
594	1726,6	1821,6	6906,4	7286,4	688	1745,4	1840,4	3490,8	3680,8	782	1764,2	1859,2	3528,4	3718,4	876	1783,0	1878,0	3566,0	3756,0
595	1726,8	1821,8	6907,2	7287,2	689	1745,6	1840,6	3491,2	3681,2	783	1764,4	1859,4	3528,8	3718,8	877	1783,2	1878,2	3566,4	3756,4
596	1727,0	1822,0	6908,0	7288,0	690	1745,8	1840,8	3491,6	3681,6	784	1764,6	1859,6	3529,2	3719,2	878	1783,4	1878,4	3566,8	3756,8
597	1727,2	1822,2	6908,8	7288,8	691	1746,0	1841,0	3492,0	3682,0	785	1764,8	1859,8	3529,6	3719,6	879	1783,6	1878,6	3567,2	3757,2
598	1727,4	1822,4	6909,6	7289,6	692	1746,2	1841,2	3492,4	3682,4	786	1765,0	1860,0	3530,0	3720,0	880	1783,8	1878,8	3567,6	3757,6
599	1727,6	1822,6	6910,4	7290,4	693	1746,4	1841,4	3492,8	3682,8	787	1765,2	1860,2	3530,4	3720,4	881	1784,0	1879,0	3568,0	3758,0
600	1727,8	1822,8	6911,2	7291,2	694	1746,6	1841,6	3493,2	3683,2	788	1765,4	1860,4	3530,8	3720,8	882	1784,2	1879,2	3568,4	3758,4
601	1728,0	1823,0	6912,0	7292,0	695	1746,8	1841,8	3493,6	3683,6	789	1765,6	1860,6	3531,2	3721,2	883	1784,4	1879,4	3568,8	3758,8
602	1728,2	1823,2	6912,8	7292,8	696	1747,0	1842,0	3494,0	3684,0	790	1765,8	1860,8	3531,6	3721,6	884	1784,6	1879,6	3569,2	3759,2
603	1728,4	1823,4	6913,6	7293,6	697	1747,2	1842,2	3494,4	3684,4	791	1766,0	1861,0	3532,0	3722,0	885	1784,8	1879,8	3569,6	3759,6
604	1728,6	1823,6	6914,4	7294,4	698	1747,4	1842,4	3494,8	3684,8	792	1766,2	1861,2	3532,4	3722,4					
605	1728,8	1823,8	6915,2	7295,2	699	1747,6	1842,6	3495,2	3685,2	793	1766,4	1861,4	3532,8	3722,8					

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GSM1900

CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX	CH	TX	RX	VCO TX	VCO RX
512	1850,2	1930,2	3700,4	3860,4	606	1869,0	1949,0	3738,0	3898,0	700	1887,8	1967,8	3775,6	3935,6	794	1906,6	1986,6	3813,2	3973,2
513	1850,4	1930,4	3700,8	3860,8	607	1869,2	1949,2	3738,4	3898,4	701	1888,0	1968,0	3776,0	3936,0	795	1906,8	1986,8	3813,6	3973,6
514	1850,6	1930,6	3701,2	3861,2	608	1869,4	1949,4	3738,8	3898,8	702	1888,2	1968,2	3776,4	3936,4	796	1907,0	1987,0	3814,0	3974,0
515	1850,8	1930,8	3701,6	3861,6	609	1869,6	1949,6	3739,2	3899,2	703	1888,4	1968,4	3776,8	3936,8	797	1907,2	1987,2	3814,4	3974,4
516	1851,0	1931,0	3702,0	3862,0	610	1869,8	1949,8	3739,6	3899,6	704	1888,6	1968,6	3777,2	3937,2	798	1907,4	1987,4	3814,8	3974,8
517	1851,2	1931,2	3702,4	3862,4	611	1870,0	1950,0	3740,0	3900,0	705	1888,8	1968,8	3777,6	3937,6	799	1907,6	1987,6	3815,2	3975,2
518	1851,4	1931,4	3702,8	3862,8	612	1870,2	1950,2	3740,4	3900,4	706	1889,0	1969,0	3778,0	3938,0	800	1907,8	1987,8	3815,6	3975,6
519	1851,6	1931,6	3703,2	3863,2	613	1870,4	1950,4	3740,8	3900,8	707	1889,2	1969,2	3778,4	3938,4	801	1908,0	1988,0	3816,0	3976,0
520	1851,8	1931,8	3703,6	3863,6	614	1870,6	1950,6	3741,2	3901,2	708	1889,4	1969,4	3778,8	3938,8	802	1908,2	1988,2	3816,4	3976,4
521	1852,0	1932,0	3704,0	3864,0	615	1870,8	1950,8	3741,6	3901,6	709	1889,6	1969,6	3779,2	3939,2	803	1908,4	1988,4	3816,8	3976,8
522	1852,2	1932,2	3704,4	3864,4	616	1871,0	1951,0	3742,0	3902,0	710	1889,8	1969,8	3779,6	3939,6	804	1908,6	1988,6	3817,2	3977,2
523	1852,4	1932,4	3704,8	3864,8	617	1871,2	1951,2	3742,4	3902,4	711	1890,0	1970,0	3780,0	3940,0	805	1908,8	1988,8	3817,6	3977,6
524	1852,6	1932,6	3705,2	3865,2	618	1871,4	1951,4	3742,8	3902,8	712	1890,2	1970,2	3780,4	3940,4	806	1909,0	1989,0	3818,0	3978,0
525	1852,8	1932,8	3705,6	3865,6	619	1871,6	1951,6	3743,2	3903,2	713	1890,4	1970,4	3780,8	3940,8	807	1909,2	1989,2	3818,4	3978,4
526	1853,0	1933,0	3706,0	3866,0	620	1871,8	1951,8	3743,6	3903,6	714	1890,6	1970,6	3781,2	3941,2	808	1909,4	1989,4	3818,8	3978,8
527	1853,2	1933,2	3706,4	3866,4	621	1872,0	1952,0	3744,0	3904,0	715	1890,8	1970,8	3781,6	3941,6	809	1909,6	1989,6	3819,2	3979,2
528	1853,4	1933,4	3706,8	3866,8	622	1872,2	1952,2	3744,4	3904,4	716	1891,0	1971,0	3782,0	3942,0	810	1909,8	1989,8	3819,6	3979,6
529	1853,6	1933,6	3707,2	3867,2	623	1872,4	1952,4	3744,8	3904,8	717	1891,2	1971,2	3782,4	3942,4					
530	1853,8	1933,8	3707,6	3867,6	624	1872,6	1952,6	3745,2	3905,2	718	1891,4	1971,4	3782,8	3942,8					
531	1854,0	1934,0	3708,0	3868,0	625	1872,8	1952,8	3745,6	3905,6	719	1891,6	1971,6	3783,2	3943,2					
532	1854,2	1934,2	3708,4	3868,4	626	1873,0	1953,0	3746,0	3906,0	720	1891,8	1971,8	3783,6	3943,6					
533	1854,4	1934,4	3708,8	3868,8	627	1873,2	1953,2	3746,4	3906,4	721	1892,0	1972,0	3784,0	3944,0					
534	1854,6	1934,6	3709,2	3869,2	628	1873,4	1953,4	3746,8	3906,8	722	1892,2	1972,2	3784,4	3944,4					
535	1854,8	1934,8	3709,6	3869,6	629	1873,6	1953,6	3747,2	3907,2	723	1892,4	1972,4	3784,8	3944,8					
536	1855,0	1935,0	3710,0	3870,0	630	1873,8	1953,8	3747,6	3907,6	724	1892,6	1972,6	3785,2	3945,2					
537	1855,2	1935,2	3710,4	3870,4	631	1874,0	1954,0	3748,0	3908,0	725	1892,8	1972,8	3785,6	3945,6					
538	1855,4	1935,4	3710,8	3870,8	632	1874,2	1954,2	3748,4	3908,4	726	1893,0	1973,0	3786,0	3946,0					
539	1855,6	1935,6	3711,2	3871,2	633	1874,4	1954,4	3748,8	3908,8	727	1893,2	1973,2	3786,4	3946,4					
540	1855,8	1935,8	3711,6	3871,6	634	1874,6	1954,6	3749,2	3909,2	728	1893,4	1973,4	3786,8	3946,8					
541	1856,0	1936,0	3712,0	3872,0	635	1874,8	1954,8	3749,6	3909,6	729	1893,6	1973,6	3787,2	3947,2					
542	1856,2	1936,2	3712,4	3872,4	636	1875,0	1955,0	3750,0	3910,0	730	1893,8	1973,8	3787,6	3947,6					
543	1856,4	1936,4	3712,8	3872,8	637	1875,2	1955,2	3750,4	3910,4	731	1894,0	1974,0	3788,0	3948,0					
544	1856,6	1936,6	3713,2	3873,2	638	1875,4	1955,4	3750,8	3910,8	732	1894,2	1974,2	3788,4	3948,4					
545	1856,8	1936,8	3713,6	3873,6	639	1875,6	1955,6	3751,2	3911,2	733	1894,4	1974,4	3788,8	3948,8					
546	1857,0	1937,0	3714,0	3874,0	640	1875,8	1955,8	3751,6	3911,6	734	1894,6	1974,6	3789,2	3949,2					
547	1857,2	1937,2	3714,4	3874,4	641	1876,0	1956,0	3752,0	3912,0	735	1894,8	1974,8	3789,6	3949,6					
548	1857,4	1937,4	3714,8	3874,8	642	1876,2	1956,2	3752,4	3912,4	736	1895,0	1975,0	3790,0	3950,0					
549	1857,6	1937,6	3715,2	3875,2	643	1876,4	1956,4	3752,8	3912,8	737	1895,2	1975,2	3790,4	3950,4					
550	1857,8	1937,8	3715,6	3875,6	644	1876,6	1956,6	3753,2	3913,2	738	1895,4	1975,4	3790,8	3950,8					
551	1858,0	1938,0	3716,0	3876,0	645	1876,8	1956,8	3753,6	3913,6	739	1895,6	1975,6	3791,2	3951,2					
552	1858,2	1938,2	3716,4	3876,4	646	1877,0	1957,0	3754,0	3914,0	740	1895,8	1975,8	3791,6	3951,6					
553	1858,4	1938,4	3716,8	3876,8	647	1877,2	1957,2	3754,4	3914,4	741	1896,0	1976,0	3792,0	3952,0					
554	1858,6	1938,6	3717,2	3877,2	648	1877,4	1957,4	3754,8	3914,8	742	1896,2	1976,2	3792,4	3952,4					
555	1858,8	1938,8	3717,6	3877,6	649	1877,6	1957,6	3755,2	3915,2	743	1896,4	1976,4	3792,8	3952,8					
556	1859,0	1939,0	3718,0	3878,0	650	1877,8	1957,8	3755,6	3915,6	744	1896,6	1976,6	3793,2	3953,2					
557	1859,2	1939,2	3718,4	3878,4	651	1878,0	1958,0	3756,0	3916,0	745	1896,8	1976,8	3793,6	3953,6					
558	1859,4	1939,4	3718,8	3878,8	652	1878,2	1958,2	3756,4	3916,4	746	1897,0	1977,0	3794,0	3954,0					
559	1859,6	1939,6	3719,2	3879,2	653	1878,4	1958,4	3756,8	3916,8	747	1897,2	1977,2	3794,4	3954,4					
560	1859,8	1939,8	3719,6	3879,6	654	1878,6	1958,6	3757,2	3917,2	748	1897,4	1977,4	3794,8	3954,8					
561	1860,0	1940,0	3720,0	3880,0	655	1878,8	1958,8	3757,6	3917,6	749	1897,6	1977,6	3795,2	3955,2					
562	1860,2	1940,2	3720,4	3880,4	656	1879,0	1959,0	3758,0	3918,0	750	1897,8	1977,8	3795,6	3955,6					
563	1860,4	1940,4	3720,8	3880,8	657	1879,2	1959,2	3758,4	3918,4	751	1898,0	1978,0	3796,0	3956,0					
564	1860,6	1940,6	3721,2	3881,2	658	1879,4	1959,4	3758,8	3918,8	752	1898,2	1978,2	3796,4	3956,4					
565	1860,8	1940,8	3721,6	3881,6	659	1879,6	1959,6	3759,2	3919,2	753	1898,4	1978,4	3796,8	3956,8					
566	1861,0	1941,0	3722,0	3882,0	660	1879,8	1959,8	3759,6	3919,6	754	1898,6	1978,6	3797,2	3957,2					
567	1861,2	1941,2	3722,4	3882,4	661	1880,0	1960,0	3760,0	3920,0	755	1898,8	1978,8	3797,6	3957,6					
568	1861,4	1941,4	3722,8	3882,8	662	1880,2	1960,2	3760,4	3920,4	756	1899,0	1979,0	3798,0	3958,0					
569	1861,6	1941,6	3723,2	3883,2	663	1880,4	1960,4	3760,8	3920,8	757	1899,2	1979,2	3798,4	3958,4					
570	1861,8	1941,8	3723,6	3883,6	664	1880,6	1960,6	3761,2	3921,2	758	1899,4	1979,4	3798,8	3958,8					
571	1862,0	1942,0	3724,0	3884,0	665	1880,8	1960,8	3761,6	3921,6	759	1899,6	1979,6	3799,2	3959,2					
572	1862,2	1942,2	3724,4	3884,4	666	1881,0	1961,0	3762,0	3922,0	760	1899,8	1979,8	3799,6	3959,6					
573	1862,4	1942,4	3724,8	3884,8	667	1881,2	1961,2	3762,4	3922,4	761	1900,0	1980,0	3800,0	3960,0					
574	1862,6	1942,6	3725,2	3885,2	668	1881,4	1961,4	3762,8	3922,8	762	1900,2	1980,2	3800,4	3960,4					
575	1862,8	1942,8	3725,6	3885,6	669	1881,6	1961,6	3763,2	3923,2	763	1900,4	1980,4	3800,8	3960,8					
576	1863,0	1943,0	3726,0	3886,0	670	1881,8	1961,8	3763,6	3923,6	764	1900,6	1980,6	3801,2	3961,2					
577	1863,2	1943,2	3726,4	3886,4	671	1882,0	1962,0	3764,0	3924,0	765	1900,8	1980,8	3801,6	3961,6					
578	1863,4	1943,4	3726,8	3886,8	672	1882,2	1962,2	3764,4	3924,4	766	1901,0	1981,0	3802,0	3962,0					
579	1863,6	1943,6	3727,2	3887,2	673	1882,4	1962,4	3764,8	3924,8	767	1901,2	1981,2	3802,4	3962,4					
580	1863,8	1943,8	3727,6	3887,6	674	1882,6	1962,6	3765,2	3925,2	768	1901,4	1981,4	3802,8	3962,8					
581	1864,0	1944,0	3728,0	3888,0	675	1882,8	1962,8	3765,6	3925,6	769	1901,6	1981,6	3803,2	3963,2					
582	1864,2	1944,2	3728,4	3888,4	676	1883,0	1963,0	3766,0	3926,0	770	1901,8	1981,8	3803,6	3963,6					
583	1864,4	1944,4	3728,8	3888,8	677	1883,2	1963,2	3766,4	3926,4	771	1902,0	1982,0	3804,0	3964,0					
584	1864,6	1944,6	3729,2	3889,2	678	1883,4	1963,4	3766,8	3926,8	772	1902,2	1982,2	3804,4	3964,4					
585	1864,8	1944,8	3729,6	3889,6	679	1883,6	1963,6	3767,2	3927,2	773	1902,4	1982,4	3804,8	3964,8					
586	1865,0	1945,0	3730,0	3890,0	680	1883,8	1963,8	3767,6	3927,6	774	1902,6	1982,6	3805,2	3965,2					
587	1865,2	1945,2	3730,4	3890,4	681	1884,0	1964,0	3768,0	3928,0	775	1902,8	1982,8	3805,6	3965,6					
588	1865,4	1945,4	3730,8	3890,8	682	1884,2	1964,2	3768,4	3928,4	776	1903,0	1983,0	3806,0	3966,0					
589	1865,6	1945,6	3731,2	3891,2	683	1884,4	1964,4	3768,8	3928,8	777	1903,2	1983,2	3806,4	3966,4					
590	1865,8	1945,8	3731,6	3891,6	684	1884,6	1964,6	3769,2	3929,2	778	1903,4	1983,4	3806,8	3966,8					
591	1866,0	1946,0	3732,0	3892,0	685	1884,8	1964,8	3769,6	3929,6	779	1903,6	1983,6	3807,2	3967,2					
592	1866,2	1946,2	3732,4	3892,4	686	1885,0	1965,0	3770,0	3930,0	780	1903,8	1983,8	3807,6	3967,6					
593	1866,4	1946,4	3732,8	3892,8	687	1885,2	1965,2	3770,4	3930,4	781	1904,0	1984,0	3808,0	3968,0					
594	1866,6	1946,6	3733,2	3893,2	688	1885,4	1965,4	3770,8	3930,8	782	1904,2	1984,2	3808,4	3968,4					
595	1866,8	1946,8	3733,6	3893,6	689	1885,6	1965,6	3771,2	3931,2	783	1904,4	1984,4	3808,8	3968,8					
596	1867,0	1947,0	3734,0	3894,0	690	1885,8	1965,8	3771,6	3931,6	784	1904,6	1984,6	3809,2	3969,2					
597	1867,2	1947,2	3734,4	3894,4	691	1886,0	1966,0	3772,0	3932,0	785	1904,8	1984,8	3809,6	3969,6					
598	1867,4	1947,4	3734,8	3894,8	692	1886,2	1966,2	3772,4	3932,4	786	1905,0	1985,0	3810,0	3970,0					
599	1867,6	1947,6	3735,2	3895,2	693	1886,4	1966,4	3772,8	3932,8	787	1905,2	1985,2	3810,4	3970,4					
600	1867,8	1947,8	3735,6	3895,6	694	1886,6	1966,6	3773,2	3933,2	788	1905,4	1985,4	3810,8	3970,8					
601	1868,0	1948,0	3736,0	3896,0	695	1886,8	1966,8	3773,6	3933,6	789	1905,6	1985,6	3811,2	3971,2					
602	1868,2	1948,2	3736,4	3896,4	696	1887,0	1967,0	3774,0	3934,0	790	1905,8	1985,8	3811,6	3971,6					
603	1868,4	1948,4	3736,8	3896,8	697	1887,2	1967,2	3774,4	3934,4	791	1906,0	1986,0	3812,0	3972,0					
604	1868,6	1948,6	3737,2	3897,2	698	1887,4	1967,4	3774,8	3934,8	792	1906,2	1986,2	3812,4	3972,4					
605	1868,8	1948,8	3737,6	3897,6	699	1887,6	1967,6	3775,2	3935,2	793	1906,4	1986,4	3812,8	3972,8					

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